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Second Report of the Director of Veterinary Research, October, 1912.*

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P. J. DU TOIT,
Director of Veterinary Services and Animal Industry.

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Section I.

Protozoal Diseases.

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Bovine Anaplasmosis: A method of obtaining Pure Strains of *Anaplasma marginale* and *Anaplasma centrale* by Transmission through Antelopes.

By W. O. NEITZ, B.V.Sc., Veterinary Research Officer, Onderstepoort, and

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INTRODUCTION.

THE rôle that antelopes play as reservoirs for trypanosomes pathogenic to man and domesticated animals has frequently been investigated. Very little, however, is known of the extent to which antelopes may act as hosts for diseases such as Babesiosis, Piroplasmosis, Theileriasis and Anaplasmosis which affect our domesticated animals.

In a continent like Africa where game is so abundant in certain areas, it is necessary to investigate this problem in order to improve our methods of controlling such diseases.

In this article the experimental transmission of bovine anaplasmosis by blood subinoculations is discussed. The possible transmission by ticks has yet to be investigated.

The family Bovidae contains not only cattle, sheep and goats, but also the antelopes. It is exceedingly difficult to separate the antelopes from the above species, but their inclusion into one family, Bovidae, shows that no important difference exists as far as the general anatomy is concerned. As far as we know, antelopes are the oldest of all bovine animals, and in them one finds a combination of the characteristics of cattle, sheep and goats.

Antelopes are now limited to Africa, Asia and Europe, and are no longer as numerous as formerly.

We know that some parasites belonging to the families Babesidae, Theileridae and Anaplasmidae may be transmitted from one member of the family Bovidae to another, e.g. *P. bigeminum* and *A. marginale* from the ox to the buffalo; *Th. ovis* and *Th. recondita* and *A. ovis* from the sheep to the goat.

Lignières (1919) states that he was able to transmit *A. argentinum* from cattle into sheep and goats and from the latter two animals back into cattle. He mentions the fact that by this method he has been able to attenuate *A. argentinum* and that he considered this as a method for producing a vaccine. Also he

mentions that it was possible to obtain pure strains of Anaplasma by passage through sheep and goats. He was never able to demonstrate *A. argentinum* in blood smears of sheep and goats, neither did he notice any clinical symptoms in the animals mentioned.

Donatien and Lestoquard (1930), who recognize two species of anaplasma, viz., *A. marginale* and *A. ovis*, claim to have been successful in transmitting the former from cattle to sheep and from the latter back to cattle. Furthermore they claim to have passed *A. marginale* through several generations in sheep and then back into cattle. They describe the infection in sheep as a latent infection, but state that the *A. marginale* that was passed through sheep produced an acute anaplasmosis reaction in cattle. On the other hand they maintain that they have not been successful in transmitting *A. ovis* to cattle. In conclusion they add that as Piroplasmosis, Theileriasis and Anaplasmosis occur together they are able by this method to obtain a pure strain of *A. marginale*.

EXPERIMENTAL OBSERVATIONS.

In order to determine whether bovine piroplasmosis, Theileriasis and Anaplasmosis are transmissible to antelopes subinoculations were carried out in three blesbuck (*Damaliscus albifrons*) and one duiker (*Sylvicapra grimmi grimmi* L.).

The blesbuck were obtained from Theunissen, O.F.S., and arrived at Onderstepoort on 9.5.31. It is not known to what extent ticks occur at Theunissen, but on arrival no ticks could be found on the animals. The duiker was purchased from the Pretoria Zoological Gardens on 7.10.31, but the place of origin of the buck was unknown. No ticks could be found on this animal. The four buck were males and in order to handle them more easily they were castrated. During the time the animals were in experiment they were kept in a stable, and were allowed into an apparently tick-free camp for exercise. At no time was it possible during the observations to find any ticks on these animals.

The investigational work comprised three series of experiments as follows:—

I. the transmission of *A. marginale* to a blesbuck.
II. the transmission of *A. marginale* to a duiker.
III. the transmission of *A. centrale* to a blesbuck.

I. THE TRANSMISSION OF ANAPLASMA MARGINALE TO A BLESBUCK (DAMALISCUS ALBIFRONS).

Before commencing transmission experiments to blesbuck an endeavour was made to ascertain whether the buck were free of blood parasites. The details are recorded in the following experiments.

EXPERIMENT 1 (S. 4417).

Object: To ascertain whether it is possible to demonstrate microscopically blood parasites belonging to the families Babesidae, Theileridae and Anaplasmidae in the blesbuck.

Method: Blood smears were examined twice weekly for a period of ten, four and nine weeks in case of Blesbuck 32054, 32055 and 32056 respectively. These three animals were further kept on daily temperature, but at no time did the thermal reaction arouse suspicion.

Result: No blood parasites could be demonstrated microscopically in the mentioned bucks.

EXPERIMENT 2.

Object: To ascertain whether any one of the blesbuck harbour blood parasites transmissible to bovines.

Method: 10 c.c. of blood from blesbuck 32054 was subinoculated subcutaneously into calf 4526, which was reared under entirely tick-free conditions. Blood smears were examined for a period of ten weeks.

Result: No blood parasites could be demonstrated in the subinoculated calf.

Conclusion: Blesbuck 32054 did not harbour any parasites transmissible to bovines.

It was assumed that since blesbuck 32054 was free of blood parasites, that blesbuck 32055, which was kept under identical conditions as the former, would also be free. Not sufficient calves reared under tick-free conditions were available at the time in order to test each blesbuck separately.

EXPERIMENT 3.

Object: To transmit *P. bigeminum*, *Th. mutans* and *A. marginale* to one of the buck.

Method: 10 c.c. blood from calf 4231 which harboured *P. bigeminum Th. mutans* and a virulent strain of *A. marginale* was injected intravenously into blesbuck 32055.

Result: It was not possible to demonstrate *P. bigeminum* and *Th. mutans* microscopically, but 25 days after subinoculation *A. marginale* appeared and could be demonstrated for a period of 14 days. Up to 5 per cent. of the erythrocytes were infected with *A. marginale*, of which 90 per cent. were marginal forms. The blesbuck did not manifest any clinical symptoms as a result of the infection, but the blood showed anisocytosis.

EXPERIMENT 4.

Object: (i) To ascertain whether a latent infection of *P. bigeminum* and *Th. mutans* existed in blesbuck 32055.

(ii) *a*. To confirm the diagnosis of *A. marginale*.

b. To note whether virulence and morphology of *A. marginale* has changed by passage.

Method: 5 c.c. blood from blesbuck 32055 was injected subcutaneously into each of the following cattle:—

(i) 4285, a 6-month-old calf that was known to harbour only *Th. mutans*.

(ii) 4249, a 7-month-old presumably susceptible calf.

(iii) 3532, a 5-year-old susceptible ox.

Result: *P. bigeminum* could not be demonstrated in the above three bovines. Bovine 3532 remained free from *Th. mutans.* After an incubation period of 16 days in the case of calf 4249 and 18 days in calf 4285 *A. marginale* appeared. Neither of these calves ever showed any clinical symptoms, although the blood smears showed typical anaemic changes, viz., anisocytosis, basophilia, polychromasia, Jolly bodies and normoblasts. About 10 per cent. of the erythrocytes were infected with *A. marginale*, 90 per cent. of which were situated at the margin. Bovine 4249 showed *Th. mutans* 12 weeks after subinoculation. This was considered an accidental infection since the calf was not kept in a tick-free stable.

In case of bovine 3532 the incubation period for *A. marginale* was 15 days. This animal showed a typical anaplasmosis reaction, viz., anaemia, icterus, inappetence, listlessness and constipation; the last mentioned being treated satisfactorily by a purgative. About 25 per cent. of the erythrocytes were infected with *A. marginale*, of which 90 per cent. were marginal forms.

TABLE 1.—EXPERIMENT 4.

D.O.B. No. of Animal.	Date of Injection.	Injected from.	Incubation Period in Days of *A. marginale*.	Per Cent. of Erythrocytes Infected.	Per Cent. of Marginal Forms.	Remarks.
Blesbuck 32055	5.6.31	4231	25	5	90	No clinical symptoms. Slight anaemic changes.
Calf 4249	8.7.31	32055	16	10	90	No clinical symptoms. Marked anaemic changes.
Calf 4285	9.7.31	32055	18	10	90	No clinical symptoms. Marked anaemic changes.
Ox 3532..	1.9.31	32055	15	25	90	Typical anaplasmosis reaction, with anaemic changes in blood.

EXPERIMENT 5.

Object: To ascertain whether *A. marginale* from blesbuck 32055 can be transmitted to sheep.

Method: 10 c.c. blood from blesbuck 32055 was inoculated into two sheep, 31751 and 32228, which were obtained from an anaplasmosis-free area, Schoombie, Cape Province.

Result: It was never possible to demonstrate any blood parasites microscopically in these sheep for a period of 7 weeks after subinoculation.

EXPERIMENT 6.

Object: To see whether it is possible to demonstrate *A. marginale* by subinoculation of blood into susceptible calf from sheep.

Method: Blood from sheep 32228 and 31751 was pooled and 20 c.c. injected subcutaneously into a susceptible calf, 4526.

Result: After an incubation period of 28 days *A. marginale* could be demonstrated in calf 4526. Apart from a moderate febrile reaction 105° F., no other clinical symptoms could be observed. About 25 per cent. of the erythrocytes were infected with *A. marginale*, of which 90 per cent. were marginal forms. Blood smears showed typical anaemic changes, viz., anisocytosis, basophilia, polychromasia, Jolly bodies, and normoblasts.

Further details of Experiments 5 and 6 are given in Table 2.

TABLE 2.—EXPERIMENTS 5 AND 6.

D.O.B. No. of Animal.	Date of Injection.	Injected from.	Incubation Period in Days.	Per Cent. of Erythrocytes Infected.	Per Cent. of Marginal Forms.	Remarks.
31751....	1.9.31	32055, 10 c.c.	—	—	—	No clinical symptoms. *A. marginale* could not be demonstrated microscopically.
32228....	1.9.31	32055, 10 c.c.	—	—	—	No clinical symptoms. *A. marginale* could not be demonstrated microscopically.
4526.....	8.2.32	32228, 31751, 20 c.c. subcut.	28	25	90	Typical *A. marginale* seen. Moderate febrile reaction without clinical symptoms. Blood showed typical anaemic changes.

EXPERIMENT 7.

Object: To observe the effect of splenectomy on blesbuck 32055.

Method: The spleen was removed successfully, i.e. about 6 weeks after the infection with *A. marginale*.

Result: *A. marginale* reappeared in large numbers 11 days after splenectomy and could be demonstrated until death of this animal, viz., for a period of 50 days. 25 per cent. of the erythrocytes were infected with *A. marginale*, of which about 90 per cent. were marginal forms. During the time that the parasites were frequent anisocytosis and slight basophilia were noted. It was at no time possible to demonstrate any parasites other than *A. marginale*.

This buck was suffering from a marked verminosis and gradually lost condition, dying on 12.9.31. At post-mortem examination a heavy infection of *Haemonchus contortus* and *Impalaia nudicollis* was found. Death was ascribed to verminosis.

Conclusions.

1. The three blesbuck before blood inoculation did not harbour any parasites that could be demonstrated microscopically.

2. Blesbuck 32054 did not harbour any parasites transmissible to the bovine 4526.

3. Neither *P. bigeminum* nor *Th. mutans* could be transmitted to blesbuck 32055. The parasites in question could not be demonstrated either before or after splenectomy, nor by subinoculation into susceptible cattle.

4. Blesbuck 32055 was susceptible to *A. marginale* but did not show any clinical symptoms before or after splenectomy. The emaciation and death are ascribed to verminosis.

5. *A. marginale* neither lost its virulence nor its characteristic morphology by passage through blesbuck 32055.

6. The fact that blesbuck 32055 was successfully infected with *A. marginale*, but proved to be refractive to infection with *P. bigeminum* and *Th. mutans*, indicates a simple way of separating these three parasites which usually occur together in South African bovines, and thus obtaining a pure infection of *A. marginale*.

7. *A marginale* from blesbuck is transmissible to sheep in which it appears as a latent infection.

II. THE TRANSMISSION OF A. marginale TO A DUIKER (Sylvicapra grimmi grimmi L.).

In the previous set of experiments it was possible to transmit *A. marginale* to a blesbuck. It was, therefore, decided to ascertain whether the duiker was also susceptible, and the series of experiments described below were carried out with this object in view.

EXPERIMENT 8 (S. 4521).

Object: To determine whether it is possible to demonstrate microscopically blood parasites belonging to the family Babesidae, Theileridae or Anaplasmidae in duiker 32806.

Method: Daily blood smears were examined for a period of four weeks. The temperatures taken twice daily were in all cases normal.

Result: It was not possible to demonstrate blood parasites microscopically.

EXPERIMENT 9.

Object: To ascertain whether the duiker harbours any blood parasites which can be transmitted to bovines.

Method: 10 c.c. blood from duiker 32806 was injected subcutaneously into two calves, 4526 and 4607, reared under tick-free conditions. Daily blood smears were examined.

Result: It was not possible to demonstrate microscopically any blood parasites for a period of 15 weeks.

EXPERIMENT 10.

Object: To ascertain whether the duiker is susceptible to *P. bigeminum* and *A. marginale*.

Method: 5 c.c. blood from bovine 3019, which harboured *P. bigeminum* and a virulent strain of *A. marginale* (the same strain as mentioned in calf 4231, experiment 3), was injected subcutaneously into duiker 32806. Although bovine 3019 was injected with blood containing *P. bigeminum*, *A. marginale* and *Th. mutans*, the last mentioned never appeared in bovine 3019.

Result: It was not possible to demonstrate *P. bigeminum* in duiker 32806. 27 Days after subinoculation *A. marginale* appeared and could be demonstrated for a period of 14 days, but no clinical symptoms of the disease were noticed. Blood smears showed anaemic changes, viz., anisocytosis slight basophilia, and slight polychromasia. 2 Per cent. of the erythrocytes were infected, of which 88 per cent. were marginal forms.

EXPERIMENT 11.

Object: (i) To ascertain whether *P. bigeminum*, which could not be demonstrated microscopically, would appear on subinoculation into a bovine.

(ii) To determine whether the virulence or the morphology of *A. marginale* had undergone any change by passage through the duiker.

Method: 5 c.c. blood from duiker 32806 was injected subcutaneously into a five-year-old ox kept under tick-free conditions and susceptible to *P. bigeminum* and *A. marginale*.

Result: Neither *P. bigeminum* nor *Th. mutans* could be demonstrated microscopically in bovine 3547 for a period of 11 weeks after subinoculation, but the ox showed a typical Anaplasmosis reaction viz., temperature 105° F., inappetence ,constipation and listlessness. In order to overcome the constipation a purgative was administered on two occasions with good effect. The blood smears showed marked anaemic changes, viz., anisocytosis, basophilia, polychromasia, Jolly bodies and normoblasts. 15 per cent. of the erythrocytes were infected with *A. marginale*, of which 92 per cent were marginal forms.

TABLE 3.—EXPERIMENT 10 AND 11.

D.O.B. No. of Animal.	Date of Injection.	Injected from.	Method.	Incubation Period in Days.	Per Cent. Infection of Erythrocytes.	Per Cent. Marginal Forms.	Result and Remarks.
32806..	6.11.31	3019	10 c.c. subcut.	35	2	88	No clinical symptoms were observed. Blood showed anisocytosis, slight Basophilia, and slight polychromasia.
3547...	24.12.31	32806	10 c.c. subcut.	27	15	92	Typical clinical symptoms. Basophilia, anisocytosis, polychromasia, jolly bodies, and normoblasts.

Conclusions.

1. The duiker did not harbour any blood parasites that could be demonstrated microscopically.

2. The duiker did not harbour any parasites transmissible to bovine 4526.

3. The duiker was not susceptible to *P. bigeminum*. This parasite could neither be demonstrated microscopically in the blood of the duiker nor by subinoculation into a susceptible bovine (3547).

4. The duiker is susceptible to *A. marginale* but shows no clinical symptoms.

5. *A. marginale* lost neither its virulence nor its characteristic morphology by passage through the duiker.

6. By injecting bovine blood containing a mixture of *P. bigeminum* and *A. marginale* into a duiker the latter parasite can be obtained in a pure state.

III. THE TRANSMISSION OR Anaplasma centrale TO A BLESBUCK (Damaliscus albifrons).

As a result of obtaining a pure strain of *A. marginale* in bovine 3532 (see experiment 4) it was decided to repeat the test in order to obtain a pure strain of *A. centrale*. For this purpose blesbuck 32054 mentioned in experiments 2 and 3 was utilized. The details of this experiment (No. S. 4417) are discussed below.

EXPERIMENT 12 (S. 4417).

Object: To ascertain whether it is possible to transmit *A. centrale* to a blesbuck.

Method: 10 c.c. blood from bovine 2858 which harboured *P. bigeminum*, *Th. mutans* and *A. centrale* was injected into blesbuck 32054. Smears were examined daily.

Result: It was not possible to demonstrate any blood parasites microscopically for a period of 50 days.

As the results were negative, the experiment was repeated, using blood from another reservoir, bovine 3722, harbouring the same parasites. The daily microscopic examination again proved to be negative until the death of this animal, i.e. 95 days after subinoculation from bovine 3722; on no occasion could *A. centrale* be demonstrated.

EXPERIMENT 13.

Object: To ascertain whether it is possible to demonstrate *A. centrale* by subinoculations of blood into susceptible calves from blesbuck 32054.

Method: Blood from blesbuck 32054 was injected subcutaneously into two calves 4609 and 4611 on three occasions (See table III for details).

Result: *A. centrale* could be demonstrated in calf 4609 but not in calf 4611, which was again utilized in experiment 12. After a period of 10 weeks *Th. mutans* appeared in calf 4609, i.e. after subinoculations in experiment 14 had already been carried out. The

result was that all further subinoculations from this animal brought about a mixed infection of *A. centrale* and *Th. mutans*. It is difficult to explain why *Th. mutans* made its appearance in calf 4609. It is presumed that either mechanical or tick transmission took place. This calf was born in a camp and brought about 24 hours after birth into the tick-free stable.

EXPERIMENT 14.

Object: To confirm the diagnosis of *A. centrale* in calf 4609.

Method: 5 c.c. blood from calf 4609 was injected into calf 4613.

Result: *A. centrale* appeared 47 days later in calf 4613.

When *Th. mutans* appeared in calf 4609 it was anticipated that this parasite would also appear in the subinoculated calf. It was, however, hoped that it might still be possible to obtain a pure strain of *A. centrale* if subinoculation was carried out immediately. *A. centrale* appeared in 4613. The subinoculations were carrid out in two calves, 4604 and 4611, mentioned above. This attempt proved to be a failure, and *Th. mutans* as well as *A. centrale* appeared in both.

As a result of failing to obtain a pure strain of *A. centrale* in calf 4609 subinoculations from the blesbuck into a calf born and bred under tick-free conditions was carried out.

EXPERIMENT 15.*

Object: To obtain a pure strain of *A. centrale*.

Method: 10 c.c. blood from blesbuck 32054 was injected into calf 4627.

Result: *A. centrale* appeared 39 days later. About 10 per cent. of the cells were infected with *A. centrale*, of which 90 per cent. were central forms. The smears from this animal were examined daily but never could *Th. mutans* be demonstrated. At the time of going to press (5 months after subinoculation) calf 4627 still appears to harbour a pure infection of *A. centrale*.

EXPERIMENT 16.

Object: To confirm the diagnosis of *A. centrale* in calf 4627 by subinoculation.

Method: 10 c.c. blood was injected subcutaneously into bovine 3725 and 3723 imported from England and free not only from Anaplasma but also from *P. bigeminum* and *Th. mutans*.

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*Calf 4627 was splenectomised on 17.3.32 by Dr. Quinlan. *A. centrale* appeared in the blood five days after splenectomy. The parasites multiplied rapidly and the infection became very severe, probably due to the absence of the protective action of the spleen. The calf became very anaemic and died 20 days after splenectomy.

The blood of this calf was examined daily. As stated before, *A. centrale* was present in very large numbers in the blood, but no other parasite was ever seen. Had either *P. bigeminum* or *Th. mutans* been present in this calf, they would almost certainly have appeared after splenectomy.

The result of this experiment confirms the previous conclusion that calf 4627 harboured a pure infection of *A. centrale*.

Result: *A. centrale* appeared 32 days later in very large numbers in 3725. One, two, three, and even four anaplasmata could be demonstrated in a single cell. About 30 per cent. of erythrocytes were infected, of which 88 per cent. were central forms. The temperature rose to 106° F. There was inappetence for several days and loss of condition. The blood showed typical anaemic changes, viz., anisocytosis, basophilia, polychromasia, normoblasts, and Jolly bodies.

In case of bovine 3723 the incubation for *A. centrale* was 23 days. The blood smear examination and clinical observations were very similar to those in Bovine 3725. Blood smears were examined daily after the subinoculation had been carried out for a period of two months in case of 3723 and five months in case of 3725 but never could *Th. mutans* be demonstrated.

TABLE 4.—SUBINOCULATIONS IN EXPERIMENTS 12–16.

D.O.B. No. of Animal.	Date of Injection.	Injected from.	Method.	Date when *A. centrale* appeared.	Remarks.
32054	14.7.31	2858	10 c.c. blood subcut.	—	No blood parasites appeared.
	4.9.31	3722	,,	—	,, ,,
4609	26.8.31	32054	5 c.c. blood subcut.	14.10.31	*Th. mutans* found on 18.11.31 (9 weeks after injection).
	16.9.31	32054	10 c.c. blood subcut.		
	2.10.31	32054	,,		
4611	26.8.31	32054	5 c.c. blood subcut.	—	*Th. mutans* found 9.1.32 (8 weeks after injection).
	16.9.31	32054	10 c.c. blood suncut.		
	2.10.31	32054	,,		
	20.11.31	4609	,,	17.12.31	
4613	15.10.31	4609	5 c.c. blood subcut.	2.12.31	*Th. mutans* found 30.12.31 (11 weeks after injection).
4604	20.11.31	4613	5 c.c. blood subcut.	10.12.31	*Th. mutans* found 6.2.32 (11 weeks after injection).
4627	16.10.31	32054	10 c.c. blood subcut.	24.11.31	*Th. mutans* was never seen.
3725	13.1.32	4627	10 c.c. blood subcut.	15.2.32	*Th. mutans* was never seen.
3723	6.4.32	4627	10 c.c. blood subcut.	29.4.32	*Th. mutans* was never seen.

Conclusions.

1. *A. centrale* was transmitted to blesbuck 32054, in which it occurred as a latent infection.

2. Neither the virulence nor the characteristic morphology of *A. centrale* was changed by passage through the blesbuck.

3. The elimination of *P. bigeminum* and *Th. mutans* by passage through the blesbuck 32054 is confirmed.

4. A pure strain of *A. centrale* was obtained.

At the time of going to Press 5 months have elapsed since the subinoculation into the heifer (3725) and 2 months in case of heifer 3723, and still their blood contains only *A. centrale*. There is every reason to hope now that this infection will remain pure; and the suggestion made above that *Th. mutans* in the blood of calves 4609, 4613, 4611, 4604 was due to an accidental infection, becomes more likely. It seems, therefore, that the blesbuck (as well as the duiker and, probably, other antelopes) can be used as a " filter " to separate Anaplasma from the other blood parasites with which it is usually associated.

This separation is ordinarily no easy matter. Repeated attempts had previously been made to bring about such separation. The method used was as follows:—Blood containing a mixed infection of *P. bigeminum*, *Th. mutans* and *A. centrale* was allowed to stand at room temperature for a varying number of days. It was known that *P. bigeminum* would not survive for more than a few days, and it was hoped that *Th. mutans* would die before *A. centrale*. In that case a point would be reached where only *A. centrale* would be viable and a pure infection of this parasite could be obtained.

With this object in view the following two experiments were conducted:—

EXPERIMENT 17 (S. 4335).

Object: To obtain a pure strain of *A. centrale*.

Method: A heifer actively infected with *P. bigeminum*, *Th. mutans* and *A. centrale* was bled and the blood kept in separate bottles at room temperature. After a lapse of 9, 11, 13, 15 and 17 days the contents of one of these bottles were injected into a susceptible calf.

Result: None of these calves developed any infection at all.

Conclusion: All three parasites originally contained in the blood appeared to have died within the period of nine days.

The experiment was then repeated, using shorter periods.

EXPERIMENT 18.

Method: Blood from the same heifer used in the previous experiment was kept for 5, 6, 7, 8 and 9 days and then injected into susceptible calves.

Result: All five calves developed a *Th. mutans* infection, and only one, namely No. 4232, which had received 7-day-old blood, developed an infection with *A. centrale*.

Details of these two experiments are given in Table 5.

TABLE 5.—EXPERIMENTS 17 AND 18.

No. of Bovine.	Received 10 c.c. Blood of Bovine 3718, Subcut.	Age of Blood in Days.	Date after Injection when		
			P. bigeminum appeared.	*Th. mutans* appeared.	*A. centrale* appeared.
4255.......	22.1.31	9	—	—	—
4283.......	24.1.31	11	—	—	—
4285.......	26.1.31	13	—	—	—
4232.......	28.1.31	15	—	—	—
4288.......	30.1.31	17	—	—	—
4255.......	15·3·31	5	—	23.3.31	—
4285.......	16·3·31	6	—	8.4.31	—
4232.......	17.3.31	7	—	23.3.31	21.4.31
4288.......	18.3.31	8	—	22.4.31	—
4283.......	19.3.31	9	—	19.4.31	—

CONCLUSIONS.

1. In blood kept at room temperature *P. bigeminum* appears to die in less than 5 days.

2. *Th. mutans* survived for 5, 6, 7, 8 and in one instance, for 9 days, but not for longer.

3. *A. centrale* survived in one case for 7 days, but in two other cases it was dead after 5 and 6 days.

4. *Th. mutans* definitely seems to be more resistant than *A. centrale.*

5. There would appear to be no hope therefore of obtaining a pure strain of *A. centrale* in this way.

DISCUSSION.

In South Africa no serious attempt had been made prior to the experiments recorded in this paper to separate *A. centrale* from *Th. mutans.* There seemed to be no necessity for this. A mixture of these two parasites (together with *P. bigeminum*) has been used for years as a vaccine to protect cattle against the natural *P. bigeminum* and *A. marginale* infections. *Th. mutans* was ignored in this process, because the infection which it produced was so mild that it did not seem to influence the reaction. Never once has *Th. mutans* been known to produce a fatal reaction in the many thousands of animals inoculated in South Africa.

However, in recent years there has been a demand for the South African *A. centrale* strain for vaccine purposes from several countries (Dutch East Indies, Kenya, Southern Rhodesia, Algeria, Switzerland). In some cases apprehension was expressed at the presence of *Th. mutans* in the blood since it was feared that this parasite might become virulent under certain conditions. And indeed, cases of rather severe reactions were observed in some of the countries mentioned.

For this reason it seemed important to eliminate *Th. mutans* from the blood of the vaccine animals which are infected with *A. centrale*. This purpose has now been achieved by passing the mixed infection through a blesbuck, as described above.

SUMMARY AND GENERAL CONCLUSIONS.

1. The transmission of Anaplasma to Blesbuck, Duiker and Sheep is discussed.

2. *A. marginale* could be demonstrated microscopically in the blood of the blesbuck and the duiker. These animals do not manifest clinical symptoms as a resnlt of the infection.

3. *A. marginale* could not be seen microscopically in sheep, but was demonstrated by subinoculation into a susceptible calf.

4. *A. centrale* could not be seen microscopically in the blesbuck but was demonstrated by subinoculation into susceptible cattle.

5. *P. bigeminum* and *Th. mutans* could not be transmitted to the blesbuck and the former not to the duiker.

6. *A. marginale* and *A. centrale* were obtained in a pure state by passage through these antelopes.

7. The morphology as well as the virulence of these parasites are not changed by passage.

8. Experiments should be carried out to determine whether any other families besides the Bovidae, e.g. Cervidae and Camelidae belonging to the group Pecora are also susceptible to Anaplasmosis.

9. There is good reason to believe that Anaplasmosis can be transmitted to buck by ticks. This fact will have to be taken into consideration when measures are taken to control this disease. Furthermore, this may explain why Anaplasmosis occurs on farms where it is known to be absent for years.

10. The evidence available seems to indicate that Anaplasmosis was primarily a disease of antelopes and that bovines were infected when brought into areas where the disease occurred.

ACKNOWLEDGMENTS.

Thanks are due to Dr. J. B. Quinlan for carrying out the splenectomy of one of the Blesbuck, to Mr. W. F. Averre and Mr. F. Boughton for carrying out subinoculations and preparing blood smears, to Mr. T. Meyer for preparation of photographs and to the technical office for keeping records.

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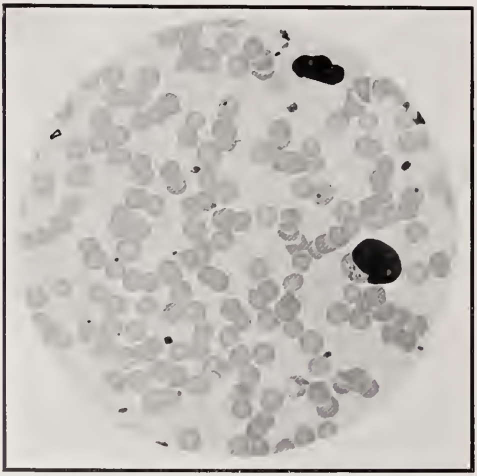

Fig. 1.—Blesbuck 32055. 8.7.31. *A. marginale* in blood smear before splenectomy. 750 ×.

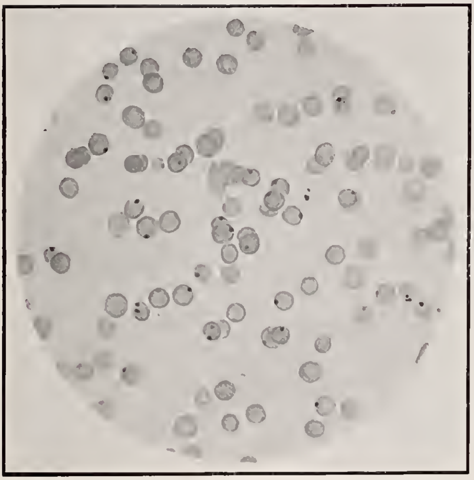

Fig. 2.—Blesbuck 32055. 31.8.31. *A. marginale* in blood smear 18 days after splenectomy. 750 ×.

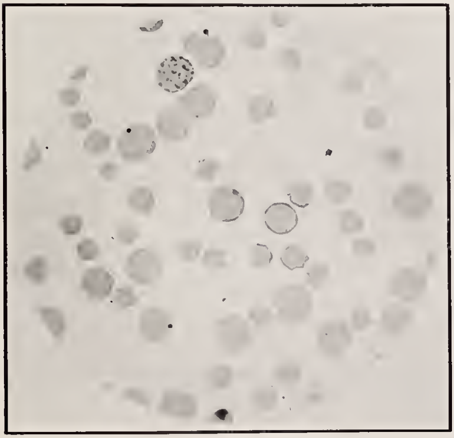

Fig. 3.—Calf 4249. 5.8.31. *A. marginale* in blood smear. 750 ×.

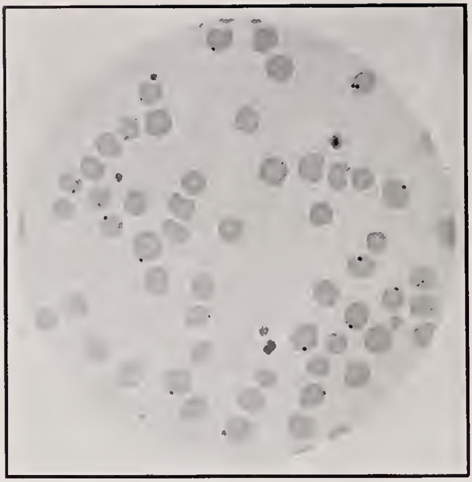

Fig. 4.—Ox 3532. 26.9.31. *A. marginale* in blood smear. 750 ×.

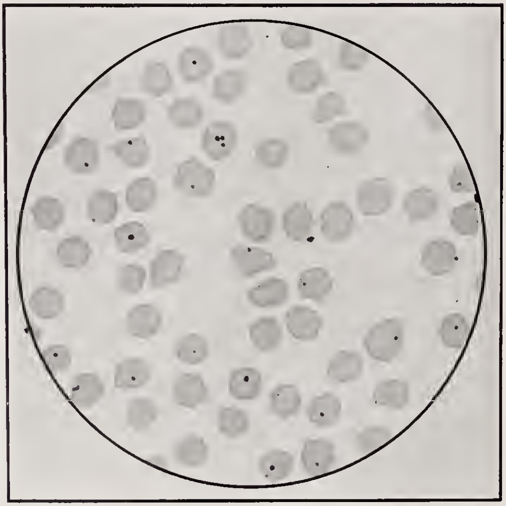

Fig. 5.—Bovine 3725. 20.2.32. *A. centrale* in blood smear. 1,050 ×.

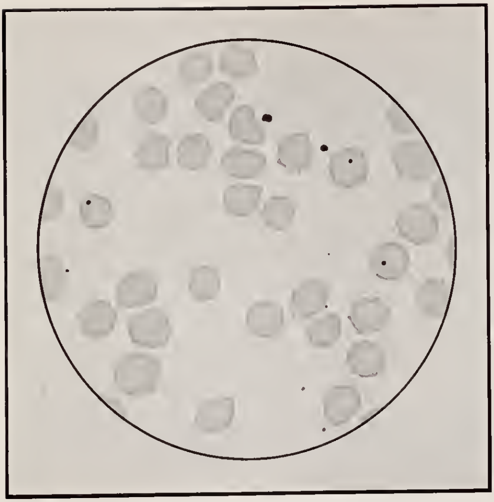

Fig. 6.—Duiker 32806. 10.12.31. *A. marginale* in blood smear. Two central forms are shown. 1,050 ×.

Fig. 7.—Bovine 3547. 26.1.32. *A. marginale* in blood smear. 1,050 ×.

Fig. 8.—Blesbuck 32054 (left) harbouring *A. centrale*. Blesbuck 32055 (right) harbouring *A. marginale*. The arrow donates the laparotomy wound.

Fig. 9.—Duiker 32806 harbouring *A. marginale*.

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

The Trypanosome Infections of *Glossina pallidipes* in the Umfolosi Game Reserve, Zululand.

(Preliminary Report.)

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INTRODUCTION.

For the study of relationship of tsetses to the flora and wild fauna, a knowledge of trypanosome infections of flies is essential. Investigations along these lines were carried out in Northern Nigeria by Lloyd and Johnson (1923). They maintain that with this knowledge one is able to gain information about the source of the bulk of their food, and important points in their bionomics, such as breeding seasons and range of flight.

The only similar investigations in Zululand comprise this brief statement by Harris (1930), " The percentage of flies showing mature infection is relatively low in endemic areas, approximately 8 per cent. of flies being so affected."

The Director of Veterinary Services instructed the writer to proceed to the Umfolosi Game Reserve in November, 1931. The present investigations were carried out at the Tsetse Fly Control Camp, situated on the south bank of the White Umfolosi River.

Zululand was at the time in the throes of one of the severest droughts experienced. Large areas of the Umfolosi Reserve were barren wastes; even the grass roots appeared to be dead. There was no food for the game and many animals had died. In numerous places even trees were dying. These conditions prevailed until 20th February, 1932, when heavy rains fell throughout Zululand, and the country made a wonderful recovery, a few weeks after the rain the grass being waist high.

The object of the investigations was to gain some indication of the percentage of tsetses showing trypanosomes in the proboscides. It was thought that data collected under the unprecedented conditions of drought would be a valuable basis for comparison with data collected when conditions again became normal. Flies have been examined from different localities within the Umfolosi Reserve, and attempts made to correlate the percentage of flies showing trypanosomes in proboscides with game, vegetation and other factors. The percentage of the sexes has been noted, while the external condition and age of the flies have also been taken into consideration.

GENERAL FEATURES OF WORK.

(1) Flora and Fauna.

A rough idea of the Umfolosi Game Reserve can be gained from the accompanying map. It is an extensive tract of country, covering about 70,000 acres, situated between the Black and White Umfolosi Rivers. The topography is a succession of hills and valleys. The major part of the country is covered with what has been described as " Savannah wooding ". Large game, white rhinoceros, buffalo, wildebeest, waterbuck, kudu and zebra are present; together with smaller animals, reedbuck, bushbuck, duiker, steenbuck, warthog and bush pigs.

(2) Material and Method.

This Reserve is the scene of the intensive trapping campaign against the tsetse fly. For this purpose 1,090 " Harris Fly Traps " were erected in suitable positions in different parts of the Reserve. The traps greatly facilitated the present study, for if tsetses were present in any locality, live flies could always be obtained from the traps there situated.

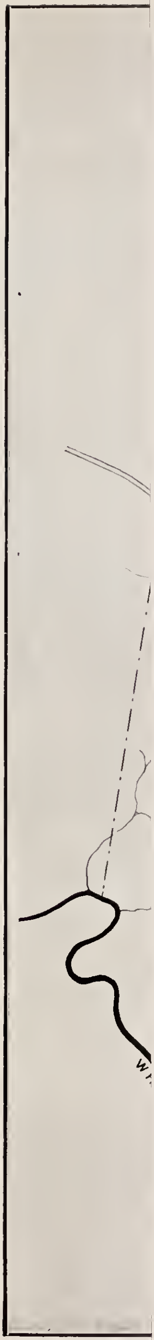
To remove the living flies from the traps a cage covered with mosquito netting, and forming a long " skirt ", was placed over the one way entrance cage of the trap, the lid being slightly opened. The tsetses readily moved from this darkened cage to the brighter cage of mosquito netting. The flies were then taken to the main camp, Impela Camp, or Little Impela Camp (according to the locality from which the flies were collected) where they were dissected. The technique used was that described by Lloyd and Johnson (1923).

When the parts for examination (labrum, hypopharynx and salivary glands) had been displayed, the preparation was examined under a microscope. Any infection was noted, fixed and stained with Giemsa. The gut of an infected fly was also examined and if trypanosomes were present, slides were prepared.

During the hot dry weather difficulty was experienced in keeping the flies alive, but later after the rains flies would remain alive for four days or longer. When once a fly was dead it was useless for dissection purposes, as it dried rapidly, and besides making the dissection of the salivary glands impossible, the trypanosome infection might also be obscured. Thus 259 flies which had been killed by spraying with a pyrethum preparation showed a percentage infection of 0·8 per cent., while after examining 321 live flies from the same locality the infection proved to be 2·8 per cent.

(3) Identification of Infections.

Three species of trypanosomes, namely, *T. vivax*, *T. congolense* and *T. brucei* were found by Curson (1928) to occur among domestic animals in Zululand. In the present study the identification of infections was based upon the position of the parasites in the fly. Thus if trypanosomes were present only in the proboscis, the infection



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was recorded as *T. vivax*; if the proboscis and gut were infected, it was recorded as *T. congolense*, and an infection of the proboscis, gut and salivary glands, was recorded as *T. brucei*. Further, the colonies of developmental forms of *T. vivax* in the labial cavity were compact, while those of *T. congolense* were diffuse (Figs. 1 and 2).

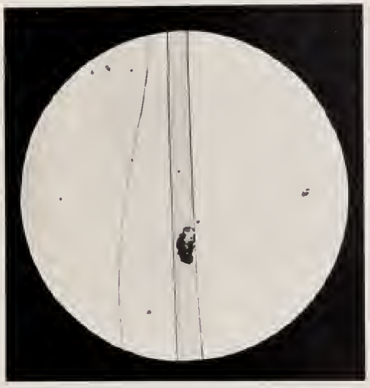

Fig. 1.—Labrum and hypopharynx of *G. pallidipes*, showing compact colony of *T. vivax* in labial cavity. × 35.

Fig. 2.—Labrum of *G. pallidipes*, showing diffuse colony of *T. congolense* in labial cavity. × 35.

(4) Condition of Flies.

As seen in Tables 1 and 2 there was a predominance of females in all the localities, ranging from 61 per cent. at Domba to 85 per cent. at Mhluzi.

A fungoid growth was noted on the ventral surface of the abdomens of a number of flies, about 2 per cent. being so affected. The hyphae were found encircling the gut. In all cases the affected flies were females. In one case the fungoid growth was noted on the eye.

Observations based on the external appearances of the fly population indicate that about 90 per cent. of the males could be regarded as "thin." 30 Per cent. to 40 per cent. of the females were noted as pregnant. This was based upon the distension of the abdomen and the presence of the black lobes of the larvae at the posterior end. Young flies, pale in colour and soft to touch, were scarce.

In a number of flies the salivary glands were swollen to almost four times their normal thickness. Nothing unusual was noted in their structure, but in two cases they were heavily infected with trypanosomes.

The gut usually contained blood in various stages of digestion. What appeared to be a symbiotic bacterium was noted most often in the gut of flies infected with *T. vivax*, but also in flies infected with *T. brucei*.

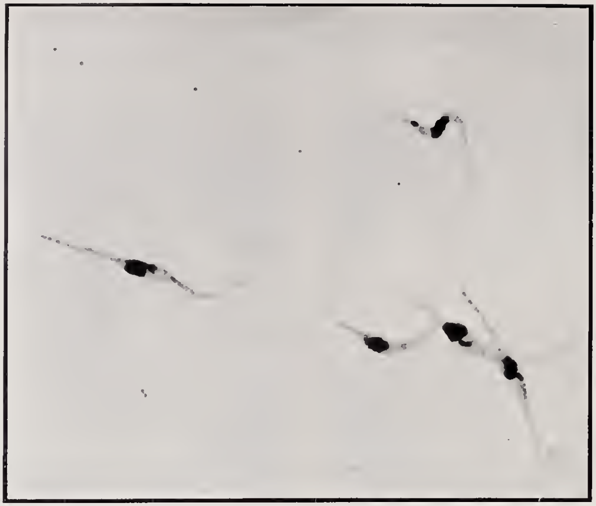

Fig. 3.—Forms of *T. vivax* from labial cavity. × 1,100.

Fig. 4.—Forms of *T. brucei* from salivary glands. × 700.

Fig. 5.—Forms of *T. brucei* from gut. × 700.

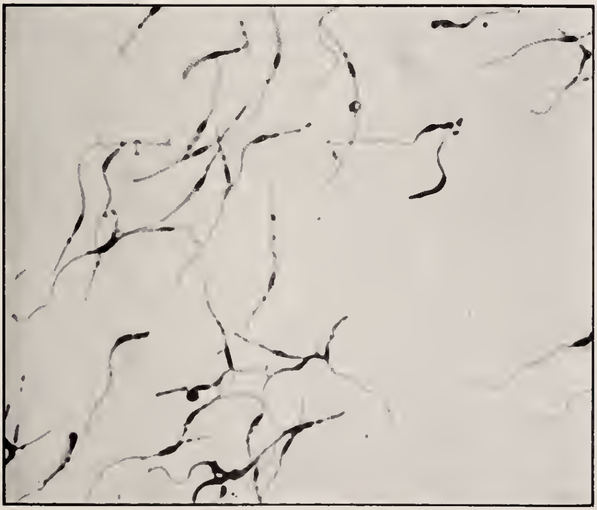

Fig. 6.—Forms of *T. congolense* from proventriculus. × 700.

Fig. 7.—Forms of *T. congolense* from gut. × 700.

RESULTS.

For purposes of comparison the results are presented in Tables 1 and 2.

An examination of 150 flies from Domba gave a percentage infection of 2·7 per cent.; 246 flies gave an infection of 2·8 per cent.; while after examining 706 flies from the same locality the percentage remained the same. It did not seem necessary, therefore, to examine a large number of flies from one locality to gain an indication of the percentage of flies showing trypanosomes in the proboscides.

DISCUSSION.

(1) Comparison of Infections in Various Localities.

The percentage of tsetses showing trypanosomes in the proboscides varies in different areas of the Umfolosi Reserve. This appears to be associated with the prevalence of game and the nature of the major vegetation of the locality from which the flies are taken.

At Mbuzana, situated in the north-west of the Reserve, the infection is 7·6 per cent. At the time when the dissections were carried out, large numbers of game had migrated from the barren Reserve, and were living on the flats to the north-west of the Mtuzini range, which in turn adjoins Mbuzana. The animals came to the Black Umfolosi to drink. In contrast with the above, at the eastern end of the Reserve, about fourteen miles distant where the Black and White Umfolosi Rivers join, the infection ranges from 5·3 per cent. to 1·9 per cent. Mbuzana is separated from the junction area by the high range of Impela hills, which extend north and south from the Black to the White Umfolosi. It can be safely said that the fly population at Mbuzana comes from a different source from that at junction area.

Table 1.

The Variation in Percentage Infection of Tsetses taken from different Localities Within the Umfolosi Reserve.

Date.	Locality.	No. of Flies Dissected.	Males.	Females.	% ♀♀	Infections.						Percentage Flies Infected.			Remarks.
						T. vivax.	*T. congolense.*	*T. brucei.*	Probably *T.v.* + *T.c.*	Probably *T.v.* + *T.b.*	Total.	Total.	Male.	Female.	
25/11/31 to 11/1/32	Domba....	706	273	433	61	10	5	—	5	—	20	2·8	2·6	3·0	Dense bush in low land near river. Game present but scarce.
12/12/31 to 6/4/32	Siyembeni.	551	88	463	84	7	5	1	4	1	18	3·3	2·3	3·5	Large bushes and trees over most of the area at junction of rivers. Game present.
12/1/32 to 14/1/32	Mbuzana..	92	15	77	84	4	1	2	—	—	7	7·6	—	9·1	During drought game concentrated on flats to north west.
26/1/32 to 4/2/32	Mhluzi....	107	16	91	85	1	—	1	—	—	2	1·9	—	2·2	Small scattered trees. Game present but scarce.
6/2/32 to 13/2/32	Dadetu....	150	31	119	79	3	3	—	2	—	8	5·3	12·9	3·4	Flies mostly from one trap near lake. Large shady trees. Suitable place for game.

TABLE 2.

THE PERCENTAGE INFECTION OF TSETSES TAKEN AT DIFFERENT INTERVALS FROM THE SAME LOCALITY.

Date.	Locality.	No. of Flies Dissected.	Males.	Females.	% ♀♀	Infections.						Percentage Flies Infected.			Remarks.
						T. vivax.	*T. congolense.*	*T. brucei.*	Probably *T.v.* + *T.c.*	Probably *T.v.* + *T.b.*	Total.	Total.	Male.	Female.	
12/12/31 to 17/12/31	Siyembeni	75	24	51	68	—	2	—	—	—	2	2·7	4·2	2·0	Severe drought conditions.
24/1/32 to 3/2/32	,,	66	12	54	82	1	—	—	—	1	2	3·0	—	3·7	Severe drought.
8/3/32 to 20/3/32	,,	350	44	306	87	6	2	1	3	—	12	3·4	2·3	3·6	Heavy rains fell on 20–22 February. Flies concentrated in this area.
3/4/32 to 6/4/32	,,	60	8	52	87	—	1	—	1	—	2	3·3	—	3·8	Flies still concentrated in this area.

Further, there is a variation of infection within the smaller area comprised of Domba, Siyembeni, Mhluzi and Dadetu. The mapority of Domba is covered with dense bush and is situated in the low land near the White Umfolozi. Game is present, but scarce. Here the infection of tsetses is 2·8 per cent., while at Siyembeni it is slightly higher, namely 3·3 per cent. Siyembeni is situated on higher ground between two rivers. The vegetation is composed of large bushes intermingled with large trees, giving a different aspect from Domba, Mhluzi and Dadetu. Numerous water pans occur at Siyembeni, and the same game apparently frequents both Domba and Siyembeni.

Mhluzi, a locality on the Black Umfolosi, is covered with small scattered trees and bushes. It adjoins Siyembeni and yet only 1·9 per cent. of the flies are infected. Game is scarce.

Dadetu, on the other hand, is conspicuous for its vegetation, composed of large shady trees and thick bushes, which cover a comparatively small area around a lake. It can be seen from higher ground many miles distant, the dark green foliage showing up against the more homogenous greyish surroundings. Most of the flies from this area were taken from a single trap situated near the lake. The locality forms an ideal focus for tsetses and is a favoured breeding place. In addition it is a likely rendezvous for game, much spoor being visible. 5·3 Per cent. of the fly population from this area are infected with trypanosomes. This relatively high infection seems to indicate that th tsetses range of flight is more limited than at first thought, for Domba, also on the White Umfolosi, is only two miles distant, and 2·8 per cent. of the flies are so infected.

(2) Seasonal Variation of Infection.

From Table 2 it will be seen that the number of infected flies from one locality does not vary much from month to month. Thus, at Siyembeni during December, 1931, the infection was 2·7 per cent., while in January and February, 1932, it was 3·0 per cent. During February heavy rains fell and a slight rise of infection is shown; in March it was 3·4 per cent. and in April it was 3·3 per cent. The data available is so limited that no reliable conclusions can be drawn.

In most areas infection is more prevalent in females than in males, though to no appreciable extent. The only exception is at Dadetu, where more males than females are infected.

After the rains in February the flies seemed to concentrate at Siyembeni. No live flies could be obtained from the traps at Domba, Dadetu, Mhluzi, Dengeza, Mbuzana or Momfu. The reason is obscure, for most of the game was apparently living round about the Impela and Matshanyama, where large herds of buffalo, zebra and wildebeest were seen. However, these animals move about a great deal and it is impossible to state that they frequent one particular area.

(3) The Species of Trypanosomes.

The most common trypanosome encountered in the fly, *G. pallidipes*, is *T. vivax*, approximately 50 per cent. of the infections eing of this parasite. It is the predominant species in each locality and very probably occurs in double infections with *T. congolense* and with *T. brucei*.

After *T. vivax*, *T. congolense* is most frequently encountered. In the fifty-five infections recorded five are *T. brucei*. This is the first time that *T. brucei* has been recorded from the salivary glands of *G. pallidipes* in Zululand, and is a point of some significance. Zululand is known to be free from sleeping sickness, although nagana is prevalent. It is possible, therefore, to find trypanosomes of the group which develop in the proboscis, gut and salivary glands of tsetses, in areas in which sleeping sickness does not occur. This seems to strengthen the claim that *T. brucei* and *T. Rhodesiense* are distinct.

Nevertheless, the other side of the question cannot be overlooked. Wenyon (1926) states that *T. gambiense* most probably originated from *T. brucei*, but has become modified morphologically to be regarded as a distinct species. The human strain of *T. brucei* (i.e. *T. Rhodesiense*), on the other hand, has only recently infected man, and, having been subjected to few passages, still maintains its morphological characters and virulence.

SUMMARY.

The paper gives an account of the trypanosome infections of *G. pallidipes* in Zululand. Attempts have been made to correlate this with game and the nature of the vegetation. Thus it appears that where most game is, the trypanoome infection of stetse is highest. Where there is water and dense floral growth the percentage of infected flies is higher than where the vegetation is of a more open nature.

T. vivax is the most commen trypanosome in the fly, followed by *T. congolense* and then *T. brucei*. It is possible for trypanosomes of the proboscis, gut and salivary gland group to occur in areas where nagana is prevalent, but sleeping sickness does not occur.

There is a predominance of females caught in the traps at all localities within the Reserve. 30 Per cent. to 40 er cent. of the females are in various stages of pregnancy, while 90 per cent. of the males are regarded as " thin ". Young flies are scarce.

CONCLUSION.

The foregoing is a preliminary report, and the investigations cover but a small area. It is hoped that investigations, not only on a larger scale but over a longer period, will be carried out in the near future.

The writer desires to express his thanks to Dr. P. J. du Toit for all facilities which enabled the work to be done; also to Mr. R. H. T. P. Harries, who allowed the writer to use portion of his laboratory, and gave valuable advice during the first stages of the work. Mr. W. Foster and Mr. S. Deakin, of the Tsetse Fly Control Camp, also gave much assistance, especially in the collecting of flies from the various localities in the Reserve.

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18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

A Note on *Aegyptianella pullorum* in the Fowl in South Africa.

By E. M. ROBINSON, D.Med.Vet., D.V.Sc., F.R.C.V.S., Sub-Director of Veterinary Services, and

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Brief Historical Survey.

In 1928 Carpano found in the blood of both indigenous and imported fowls in Egypt an organism parasitising the red corpuscles. He described also free forms in the blood. This organism was probably the *Spirochaeta granulosa penetrans*, described by Balfour. Carpano considered the parasite was not a Spirochaete and named it *Aegyptianella pullorum*. He described ruffled plumage, fever, loss of appetite, drowsiness and paralysis as being symptomatic of the disease; post-mortem lesions were confined mainly to anaemia, tumor splenis and petechiae of serous membranes. The disease was said to be mainly acute and fatal in imported birds; indigenous fowls had a marked resistance.

In the French Sudan, Curasson and Andrejesky confirmed Carpano's work shortly afterwards.

Donatien and Lestoquard found what they considered to be the same organism in Algeria in the summer of 1930. To it they attributed anaemia and death in some birds on three poultry farms run on the intensive system. Spirochaetes were not seen in these cases.

According to Brumpt the disease can be transmitted by the subcutaneous injection of infected blood. In the cases studied by him, the disease produced was of a very mild nature, and although splenectomy was performed after the parasites had disappeared from the blood, the resulting reinvasion of the red cells was of short duration and not attended with fatal consequences. Generally speaking, parasites could be found in the blood ten days after infection and began to disappear in another ten days. Brumpt says the fowl, goose, turkey, duck, pigeon, canary, quail, ringdove and guinea-fowl may all be infected.

THE POSITION IN SOUTH AFRICA.

Until October, 1931, the disease had not been seen in South Africa, although spirochaetosis is not uncommon. At this time two blood smears of a fowl were sent to the authors by Mr. F. J. Dunning, F.R.C.V.S. of Stellenbosch, Cape Province. He reported that eight two months old fowls died of a peracute disease and the remaining four birds in the run were killed. Several hundred other birds on the plant remained normal and no further cases were seen during the following two months. One dead bird was examined and nothing outstanding was seen, but the blood smears when stained with Grübler's Giemsa (1 drop per 1 c.c. aq. dist. for 1 hour) showed a very heavy infection of the red cells by an organism considered to be morphologically indistinguishable from *Aegyptianella pullorum*. These fowls were reputed to be free of all external parasites. Whether the organism was responsible for the mortality still remains uncertain.

In February, 1932, the authors made an autopsy on a pullet which was, before being killed, thin, anaemic, weak in the legs and had a fair number of *Argas persicus* larvae on the body. It showed moderate tumor splenis, enlargement and fatty degeneration of the liver and kidneys and slight intestinal catarrh. A blood smear stained with Grübler's Giemsa showed anisocytosis, polychromasia and normoblasts, and *Aegyptianella pullorum* was rather infrequent (one parasite in eight to ten fields). It is possible this fowl was suffering from anaemia produced by both the organism and the *Argas persicus* larvae. Another fowl from the same owner died and was examined. It had extensive deposits of sodium urate in the kidneys and on the surface of the liver and intestines. The blood picture resembled that in the case above but *Aegyptianella pullorum* was even less frequent. In this case it was considered the organism was not directly responsible for death.

SUMMARY AND DISCUSSION.

This short article records the presence of what is believed to be *Aegyptianella pullorum* in South Africa. The vector is unknown but is quite probably *Argas persicus*. The disease does not appear to be very important; this applies especially to the up-to-date plants where the hygiene is efficient. There is a possibility that the organism may be the cause of a chronic fatal form of anaemia which is not uncommonly seen and for which so far no etioligical factor has been discovered.

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BRUMPT, E. (1930). Rechutes parasitaires intenses, dues à la splénectomie, au cours d'infections latentes à *Aegyptianella*, chez la poule. *C.R. L'Ac. Sc.*, Vol. 191, No. 21, pp. 1028-1030.

DONATIEN, A., et LESTOQUARD, F. (1931). Présence d'*Aegyptianella pullorum* chez les poules en Algérie. *Bull. Soc. Path. Exot.*, Vol. 24, No. 5, pp. 371-372.

NOTE.—Recently Coles and Bedford have in a preliminary experiment apparently succeeded in transmitting *Aegyptianella pullorum* by *Argas persicus* (Oken).

1. 1400×. Red corpuscles showing one or two parasites.

2. 1400×. Corpuscle showing three parasites.

3. 1400×. Corpuscle showing parasites.

4. 1400×. *Aegyptianella pullorum* showing schizogony.

Section II.

Virus Diseases.

P. J. du Toit and W. O. Neitz.	The Immunization of Mules, with Formalized Horse-Sickness virus.
C. Jackson and W. O. Neitz.	On the Aetiology of Heartwater.
W. O. Neitz and I. P. Marais.	Rabies as it occurs in the Union of South Africa.
D. G. Steyn ...	East African Virus Disease in Pigs.
A. S. Canham ...	Immunization of Fowls against Fowl Pox by Use of Pigeon Pox Virus.

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

The Immunization of Mules, with Formalized Horse-sickness Virus.

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I. INTRODUCTION.

In 1930 Du Toit and Alexander reported on the immunization of *horses* against horse-sickness by the use of formalized virus. Since then the work has been continued by the present authors and the complete results obtained will be published in due course. In the present paper only those experiments, which were conducted with *mules,* will be recorded.

The *technique* employed in these experiments was essentially the same as that used and described by Du Toit and Alexander.

The immunization of mules has been practised in South Africa since 1905, when Theiler showed that an active immunity could be produced in mules by the simultaneous injection of virus and hyperimmune serum. The method has remained essentially the same and consisted of the simultaneous intrajugular injection of 5 c.c. so-called O-virus and 300 c.c. serum. According to this method some 70,000 or 80,000 mules have been immunized and the results have been very satisfactory; probably the total mortality was not higher than about 3 per cent.

It would appear, therefore, that there was no great necessity to find a new method of immunization, seeing that the virus-serum method had yielded such good results. Nevertheless, it was decided to try the effect of the formalized virus method on mules and it was hoped that several advantages would be obtained if the method proved successful: (1) the *cost* of immunization would be reduced, (2) the application of the method would be *simplified*, and (3) the *mortality* might be reduced still further. The following experiments will show that these objects have not yet been achieved.

II. EXPERIMENTAL WORK.

EXPERIMENT 1 (S. 4369).

Object of the Experiment.—To observe the effect of injecting various dilutions of formalized spleen emulsion into mules and to determine whether mules so injected are immune against horse-sickness virus.

Method.—The " vaccine " was produced in the same way as in the experiments with horses described by Du Toit and Alexander. Four horses (Nos. 19995, 19996, 19997 and 20007) were injected with O-virus. When the disease was fully developed and the horses seemed on the point of dying, they were killed and the spleen removed with full aseptic precautions. These spleens were minced separately in a Latapie mincer. The pulp was then diluted with sterile physiological NaCl solution to make a 20 per cent. emulsion. Formaldehyde was then added to the different portions in such an amount as to produce the following concentrations: 1 part formaldehyde to 1,000 parts spleen emulsion, 1 part formaldehyde to 2,000 parts emulsion, 1 to 2,500, 1 to 3,000, 1 to 3,500 and 1 to 4,000.

The so-treated spleen emulsion was then placed in an incubator for 3 days at a temperature of 37° C. After that the spleen emulsion was allowed to stand at room temperature for about 20 days before a mixture of the various dilutions was made.

The sterility of each individual flask was tested on serum-agar slopes and in serum broth. One flask with a formaldehyde dilution of 1/4,000 showed bacterial growth 24 hours later and was discarded. Five days later the various dilutions of spleen emulsion were mixed and again the sterility tested. No growth was obtained 24 hours after subculturing. The mixtures of the dilutions were made up from the following horses:

1:1,000, 1:2,000, 1:2,500, 1:3,500,

from horses 19995, 19996, 19997 and 20007.

1:3,000 and 1:4,000 from 19996, 19997 and 19995. This vaccine was made in the middle of January, 1931, and utilised in Experiment 1 (S. 4369) and also Experiment 3 (S. 4512).

Twenty mules received injections as indicated in Table No. 1. The dose injected was always 30 c.c. and the material was injected subcutaneously on the ventral surface of the neck just over the trachea, and about midway between the larynx and the entrance to the thoracic cavity. This site was chosen in order that any abscess which might form would lend itself better for treatment.

Discussion of Results.—The first five mules to be treated received two injections of vaccine, first a weaker vaccine (i.e. a higher concentration of formaldehyde) which was followed by a stronger vaccine.

The next fifteen mules received only one injection; either the concentration 1:2,500 or 1:3,000, or 1:3,500. Of these fifteen mules none died and only four showed a febrile reaction with recovery. Several of the mules were so wild that temperatures could not be taken.

Of the five mules which received two injections one (No. 20080), which received first an injection of one part formaldehyde to 2,500 parts spleen emulsion and 14 days later an injection of 1:4,000 died 12 days after the latter injection.

The immunity of the 19 mules which survived was tested after an interval varying from 14 to 61 days by the injection of 5 c.c. O-virus. Of the 19 mules two died (Nos. 20078 and 20091). Several others showed febrile reactions and recovered.

Conclusions.

1. Concentrations of 1 part formaldehyde to 1,000, 2,000, 2,500, 3,000 and 3,500 parts of a 20 per cent. virulent spleen emulsion produced reactions in some mules, but no deaths. Whereas a concentration of 1:4,000 produced death in one animal even though it had had a previous injection of 1:2,500.

2. The fact that eight mules withstood an injection of a " vaccine " consisting of 1 part formaldehyde to 3,000 parts spleen emulsion would seem to indicate that this concentration is moderately safe for mules even without any previous treatment.

3. Two mules which had received concentrations of 1:3,000 died when tested with O-virus. In the one case (20078) the interval between the injection of the vaccine and the immunity test was 61 days; in this case it was thought that the immunity produced by the " vaccine " had " worn off " after this length of time. In the other case (20091) the interval of 21 days was probably too short. On the day on which the O-virus was injected the temperature of the mule rose to 102° F. and the next day to 103·4° F. This was evidently a somewhat late reaction due to the injection of the formalized spleen emulsion. The injection of the O-virus on top of this reaction naturally aggravated the reaction and the mule died 7 days after the injection.

4. The *general conclusion* which this experiment seemed to justify was that an injection of a spleen emulsion " vaccine " containing 1 part formaldehyde to 3,000 parts emulsion appeared to be fairly safe for mules, and appeared to give sufficient immunity for the animals to withstand a test with O-virus, provided the period elapsing between the two operations was more than three weeks and less than two months.

The accuracy of this conclusion was tested out in the next experiment.

Table 1 gives all the essential details of the experiment:—

Table 1.

EXPERIMENT 1 (S. 4369).

	D.O.B. No. of Mules.	Concentration of Formaldehyde in Spleen Emulsion.						Interval in days between injections.	Result of Immunization.	Immunity Test.		
		1 : 1000	1 : 2000	1 : 2500	1 : 3000	1 : 3500	1 : 4000			Date of injection of O-Virus.	Interval in days since last injection.	Result.
1	20076	5.3.31	—	—	—	19.3.31	—	14	No reaction	2.4.31	14	6 days later showed a mild febrile reaction. Immune to horse-sickness.
2	20077	5.3.31	—	—	19.3.31	—	—	14	No reaction	2.4.31	14	5 days later showed a mild febrile reaction. Immu to horse-sickness.
3	20078	—	5.3.31	—	19.3.31	—	—	14	No reaction	19.5.31	61	6 days later showed typical febrile reaction. Died from horse-sickness, 29.5.31.
4	20079	—	5.3.31	—	—	—	19.3.31	14	6 days later showed a moderate reaction	2.4.31	14	No reaction. Immune t horse-sickness.
5	20080	—	—	5.3.31	—	—	19.3.31	14	6 days later showed typical febrile reaction and died from horse-sickness as result of 1 : 4000 on 31.3.31	—	—	—
6	20081	—	—	19.3.31	—	—	—	—	No reaction	19.5.31	61	8 days later showed a mild febrile reaction. Immune to horse-sickness.
7	20086	—	—	2.4.31	—	—	—	—	Too wild to take temperature	16.4.31	14	No reaction. Immune to horse-sickness.
8	20087	—	—	2.4.31	—	—	—	—	No reaction	16.4.31	14	6 days later showed a mild febrile reaction. Immune to horse-sickness.

9	20082	—	—	—	19.3.31	—	—	—	Too wild to take temperature	16.4.31	27	No reaction. Immune to horse-sickness.
10	20083	—	—	—	19.3.31	—	—	—	No reaction	19.5.31	61	No reaction. Immune to horse-sickness.
11	20089	—	—	—	27.4.31	—	—	—	12 days later showed marked febrile reaction	18.5.31	21	No reaction. Immune to horse-sickness.
12	20090	—	—	—	27.4.31	—	—	—	No reaction	18.5.31	21	3 days later showed a mild febrile reaction. Immune to horse-sickness.
13	20091	—	—	—	27.4.31	—	—	—	21 days later temperature rose as result of 1 : 3000	18.5.31	21	Reaction intensified by O-Virus. Died from horse-sickness, 25.5.31.
14	20092	—	—	—	27.4.31	—	—	—	No reaction	18.5.31	21	No reaction. Immune to horse-sickness.
15	20094	—	—	—	8.5.31	—	—	—	No reaction	5.6.31	29	No reaction. Immune to horse-sickness.
16	20095	—	—	—	8.5.31	—	—	—	11 days later showed typical febrile reaction.	5.6.31	29	No reaction. Immune to horse-sickness.
17	20096	—	—	—	8.5.31	—	—	—	Too wild to take temperature	5.6.31	29	No reaction. Immune to horse-sickness.
18	20097	—	—	—	8.5.31	—	—	—	Too wild to take temperature	5.6.31	29	No reaction. Immune to horse-sickness.
19	20084	—	—	—	—	26.3.31	—	—	Too wild to take temperature	19.5.31	54	No reaction. Immune to horse-sickness.
20	20085	—	—	—	—	26.3.31	—	—	No reaction	16.4.31	21	No reaction. Immune to horse-sickness.

EXPERIMENT 2 (S. 4465).

Object.—To determine whether a "vaccine" containing one part formaldehyde to 3,000 parts spleen emulsion is sufficiently safe to be injected into mules and whether the animals so treated are immune against O-virus.

Method.—A fresh supply of vaccine 1:3,000 was prepared as described before from five horses in July, 1931. The four batches referred to as B1, B2, B3 and B4 in Tables 2, 3A and 3B were prepared from the following horses:—

B1 from 20118, 20119, 20120, 20122.
B2 from 19966, 20118, 20119, 20120.
B3 from 19966, 20120, 20122.
B4 from 19966, 20119, 20120.

Fifteen mules received an injection of 30 c.c. 1:3,000 vaccine subcutaneously on the ventral surface of the neck. These animals were untrained and temperatures could not be taken; it was therefore somewhat difficult to follow the reactions accurately. Table 2 gives the details of the experiment.

Results.—Four out of the 15 mules died 10 to 12 days after the injection of the vaccine. This result was very disappointing in view of the much more encouraging results obtained in Experiment 1.

The remaining 11 mules appeared to be perfectly normal three weeks after the injection of the "vaccine". Their immunity was thereupon tested with O-virus and they all proved to be immune.

Conclusions.

1. The injection of a vaccine containing 1 part formaldehyde to 3,000 parts spleen emulsion was not safe enough for mules.

2. Mules which survived this treatment proved to be immune against O-virus.

3. To render the method safer it seemed necessary therefore first to give a higher concentration of formaldehyde to spleen emulsion before giving the mixture 1:3,000.

This was tried out in Experiment 3.

EXPERIMENT 3 (S. 4512).

Object.—To determine whether two injections of formalized spleen "vaccine", namely 1:2,000 or 1:2,500 as a first injection, followed by 1:3,000 as a second injection, are safe for mules and whether mules so treated are immune against O-virus.

Method.—As can be seen in Table No. 3A and 3B twenty mules received injections of vaccine concentrations 1:2,000 and 1:3,000 at an interval of 21 days, and 20 mules injections of 1:2,500 and 1:3,000 at the same interval.

The dilutions of 1:2,000 and 1:2,500 were from the same batch that was used in Experiment 1 (S.4369) prepared in January, 1931. The dilution of 1:3,000 was from the same batches used in Experiment 2 (S. 4465) prepared in July, 1931.

Table 3A and 3B give details of this experiment.

TABLE 2.

EXPERIMENT 2 (S. 4465).

	D.O.B. No. of Mule.	Concentration of Formaldehyde in Spleen Emulsion. 1/3000.	Result of Immunization.	Immunity Test.		
				Date of injection of O-Virus.	Interval in days since last inject.	Result.
1	20134	29.7.31 (B 1)	Died from horse-sickness on 10.8.31, 1/3000	—	—	—
2	20135	29.7.31 (B 2)	—	19.8.31	21	Immune to Horse-sickness.
3	20136	29.7.31 (B 3)	Died from horse-sickness as result, 1/3000 7.8.31	—	—	—
4	20137	29.7.31 (B 4)	—	19.8.31	21	Immune to horse-sickness.
5	20138	29.7.31 (B 4)	—	19.8.31	21	Immune to horse-sickness.
6	20139	28.8.31 (B 2)	—	18.9.31	21	Immune to horse-sickness.
7	20140	28.8.31 (B 2)	—	18.9.31	21	Immune to horse-sickness.
8	20141	28.8.31 (B 2)	—	18.9.31	21	Immune to horse-sickness.
9	20142	28.8.31 (B 2)	—	18.9.31	21	Immune to horse-sickness.
10	20143	28.8.31 (B 2)	—	18.9.31	21	Immune to horse-sickness.
11	20144	28.8.31 (B 2)	—	18.9.31	21	Immune to horse-sickness.
12	20145	28.8.31 (B 4)	—	18.9.31	21	Immune to horse-sickness.
13	20146	28.8.31 (B 4)	Died from horse-sickness as result of 1/3000 7.9.31	—	—	—
14	20147	28.8.31 (B 4)	—	18.9.31	21	Immune to horse-sickness.
15	20148	28.8.31 (B 4)	Died from horse-sickness as result of 1/3000 10.9.31	—	—	—

TABLE 3A.—EXPERIMENT 3 (S. 4512).

	D.O.B. No. of Mules.	Concentration of Formaldehyde in Spleen Emulsion.		Interval in days between Injections.	Result of Immunization.	Immunity Test.		
		1/2000.	1/3000.			Date of Injection of O-Virus.	Interval in days since last Injection.	Result.
1	20216	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
2	20217	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Dull on 9th day. Immune to horse-sickness.
3	20218	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Dull on 8th day. Immune to horse-sickness.
4	20219	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
5	20220	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
6	20221	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
7	20222	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
8	20223	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
9	20224	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
10	20225	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
11	20226	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
12	20227	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
13	20228	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.

TABLE 3A.—EXPERIMENT 3 (S. 4512) —(*continued*).

	D.O.B. No. of Mules.	Concentration of Formaldehyde in Spleen Emulsion.		Interval in days between Injections.	Result of Immunization.	Immunity Test.		
		1/2000.	1/3000.			Date of Injection of O Virus.	Interval in days since last Injection.	Result.
14	20236	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
15	20237	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
16	20238	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Died on 13.11.31 showing typical symptoms of Dunkop horse-sickness.
17	20239	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
18	20240	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
19	20241	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
20	20242	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.

TABLE 3B.—EXPERIMENT 3 (S. 4512).

	D.O.B. No. of Mules.	Concentration of Formaldehyde in Spleen Emulsion.		Interval in days between Injections.	Result of Immunization.	Immunity Test.		
		1/2000.	1/3000.			Date of Injection of O-Virus.	Interval in days since last Injection.	Result.
1	20243	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
2	20244	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
3	20245	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Dull on 9th day. Immune to horse-sickness.
4	20246	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
5	20247	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
6	20248	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
7	20249	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
8	20250	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
9	20251	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
10	20252	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
11	20253	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Died on 11.11.31 showing typical symptoms of Dunkop horse-sickness.
12	20254	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
13	20255	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.

TABLE 3B.—EXPERIMENT 3 (S. 4512)—(*continued*).

	D.O.B. No. of Mules.	Concentration of Formaldehyde in Spleen Emulsion.		Interval in days between Injections.	Result of Immunization.	Immunity Test.		
		1/2000.	1/3000.			Date of Injection of O-Virus.	Interval in days since last Injection.	Result.
14	20256	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
15	20257	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
16	20149	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
17	20150	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
18	20151	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
19	20152	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.
20	20153	24.9.31	15.10.31	21	No clinical symptoms noticed	5.11.31	21	Immune to horse-sickness.

Results.—The mules mentioned in Tables 3A and 3B went through the immunization process without showing any visible clinical symptoms of horse-sickness. The mules were too wild to be temperatured and consequently the true nature of the reaction could not be followed. The feeding was normal and mules were allowed out in a camp during the day without any ill effects.

The result of the immunity test was as follows:—

1. One of the twenty mules (20238) mentioned in Table 3A died from typical Dunkop Horse-sickness on the 8th day after the injection of O-virus. The other mules were not feeding too well from the 5th-9th day after the injection of O-virus, but with the exception of 20217 and 20218, which appeared dull on the 9th and 8th day respectively, no other clinical symptoms were observed.

2. One of the twenty mules (20253) mentioned in Table 3B died from typical Dunkop Horse-sickness on the 6th day after the injection of O-virus. The other mules were not feeding well from the 5th-9th day after the injection of O-virus, but with the exception of 20245, which appeared dull on the 9th day, no other clinical symptoms were observed.

Conclusions.

1. The results obtained in this experiment were far better than those in Experiment 2 (S. 4465) and showed that it is safer to use a higher dilution of formalin (1:2,000 or 1:2,500) before the use of 1:3,000.

2. It was anticipated, judging from the results obtained in Experiment 2 (S. 4465), that if mules withstood the reaction of 1:3,000 they would have acquired sufficient immunity to withstand the reaction as a result of the injection of O-virus. This was not the case. It is difficult to explain the deaths of the two mules (20238 and 20253). Judging from the time taken for these mules to die, it would appear that they had hardly any immunity at all.

3. It is anticipated that better results would be obtained if, instead of using 1:3,000 as a second injection, a dilution of 1:3,500 were used. This point will be verified in a future experiment.

Further points that need investigation are the pH value of the vaccine, the keeping qualities of the vaccine, the concentration of virus in the spleen, etc.

III. SUMMARY AND CONCLUSIONS.

1. The method of application and the value of formalized spleen pulp virus for the immunization of mules are discussed.

2. It is shown that dilutions up to 1 part formaldehyde to 3,500 parts spleen emulsion may be injected into mules without causing deaths; however, in some cases the injection of 1:3,000 may prove fatal.

3. To minimize this danger an injection of a stronger dilution of formaldehyde in spleen emulsion (1:2,000 or 1:2,500) may be given before the injection of 1:3,000.

4. The majority of mules that have received an injection of 1:3,000 are immune against O-virus, but a small percentage will contract horse-sickness and die.

5. In the final experiment recorded in this paper 40 mules were treated according to this method (i.e. two injections of formalized spleen, the first containing 1 part formaldehyde to 2,000 or 2,500 parts spleen emulsion, and the second 1:3,000). All these mules survived, no clinical symptoms being observed. The immunity of these mules was then tested by the injection of virulent horse-sickness virus. Two mules died, one in each group.

6. These experiments have proved that it is possible to give mules a solid immunity against horse-sickness by means of formalized spleen virus.

7. The mortality of 5 per cent. obtained in the final experiment is considered fairly satisfactory and compares favourably with the virus-serum method.

8. The method described in this paper needs further improvement and directions are indicated in which such improvements may be effected. The work is proceeding.

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On the Aetiology of Heartwater.

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WHILE it is now fairly generally believed that *Rickettsia ruminantium* Cowdry (1926) is the causal organism of heartwater, it must be admitted that the evidence so far produced has left considerable room for doubt as to the truth of an assumption based chiefly on—

(*a*) the constant occurrence of the *Rickettsia* in the tissues of affected animals over a period which corresponds roughly to the febrile reaction and the time during which the blood is infective, and

(*b*) the identification of the same organism in infective ticks.

An especially puzzling aspect of the problem has been the lack of knowledge of the relationship between the infective agent (" virus ") in the blood and the *Rickettsia* in the endothelium. The fact that it is still customary to speak of the " virus " of heartwater shows clearly that a very real doubt exists in the minds of such recent workers as Du Toit and Alexander (1931).

The demonstration by Jackson (1931) that the *Rickettsia* is present in the endothelium of large blood-vessels as well as in the capillaries provided a method whereby the infected cells could be " isolated " in a state of reasonable purity for biological investigation. This circumstance was made use of in the following experiments (Nos. S. 4443, 4454, 4467, 4471, 4475).

EXPERIMENT 1.

Object.—To test the infectivity of endothelial cells containing *Rickettsia.*

Method.—From sheep that had succumbed from artificial infections of heartwater or which had been killed at height of reaction, the jugular veins were dissected out. One vein was used for the preparation of intima smears, while the other, after its advential surface had been freed from excessive adipose and areolar tissue was attached by one end to the exit tube of a reservoir containing sterile normal saline at body temperature. The flushing was assisted by massage of vein as the fluid flowed through and was continued for some minutes after all visible traces of blood had disappeared. The

vessel was then removed, laid flat on a smooth board, opened longitudinally, and stretched out by pinning—with due regard to aseptic conditions. The intima presented a clean white appearance and scrapings of the endothelium were made in the usual way with a curette or sharp scalpel from which the material was transferred to normal saline. In one or two cases the scraped vessel was subsequently rinsed in the saline in order to obtain additional material. The resulting cell emulsion was injected intravenously into susceptible sheep as shown in Table 1.

TABLE 1.

Donor.		Recipient.			
D.O.B. No. of Sheep.	Remarks.	D.O.B. No. of Sheep.	Method.	Result.	Remarks.
25781	Jugular: Negative for *Rickettsia*. Sections: *Rickettsia* rare	23670	iv.	Died from heartwater	Jugular: *Rickettsia* rare; large groups of coccoid granules.
		28242	iv.	Died from heartwater	Jugular: *Rickettsia* rare; groups of ring forms.
28381	*Rickettsia* in kidney sections only. (Killed at height of reaction.)	31065	iv.	No reaction	—
		31131	iv.	No reaction	—
		31637	iv.	No reaction	—
		31054	iv.	Died from heartwater	Jugular: *Rickettsia* rare; small groups of medium to large sized granules.
		31423	iv.	Recovered from typical heartwater reaction	Immunity test: Not susceptible to heartwater.
		32241	iv.	Ditto.	Ditto.
31912	Jugular: *Rickettsia* frequent; large groups mainly coccoid granules, but also small ring forms	31613	iv.	Died from heartwater	Jugular: *Rickettsia* rare; small indistinct groups. Endocard: Small and large groups, granules medium size, and also large pleomorphic forms.
		31874	iv.	Recovered from typical heartwater reaction	Immunity test: Not susceptible.
31054	Jugular: *Rickettsia* rare; small groups of medium to large-sized granules	32157	iv.	No reaction....	Immunity test: Susceptible.
		31600	iv.	Died from heartwater	Jugular: *Rickettsia* frequent; groups of all sizes, ring forms prominent.
31992	Jugular: *Rickettsia* not frequent; small groups of medium-sized granules	31461	iv.	Died from heartwater	Jugular: *Rickettsia* frequent, groups of all sizes consisting of single and multiple granules of all types from coccoid to large ring forms.
		31787	iv.	Died from heartwater	Jugular: *Rickettsia* present; small and large groups consisting of medium to large sized granules; somewhat decomposed.
20826	Jugular: *Rickettsia* rare; small compact groups of medium-sized granules	31410	iv.	No reaction....	Immunity test: Susceptible to heartwater.
		31598	iv.	No reaction....	Immunity test: Susceptible to heartwater.

NOTE.—iv. indicates intravenous inoculation.

Results.—Of 16 sheep injected intravenously with endothelial cell emulsion, six did not react and ten reacted to heartwater, from which three recovered.

Comment.—The results lead to the conclusion that the *Rickettsia* is the cause of heartwater. Further, their consideration in association with previously known facts is very suggestive as to the nature of the virus in the blood: Thus

(1) Infective ticks produce heartwater; they contain *Rickettsia*.

(2) Endothelial cells can set up the disease; they also contain *Rickettsia*.

(3) The disease is transmissible by blood inoculation: the inference is that *Rickettsia* is present in the blood also.

As a matter of interest the experiment was repeated on a few sheep, using the subcutaneous route.

EXPERIMENT 2.

Object.—To ascertain the infectivity of endothelial cells injected subcutaneously.

Method.—As in Experiment 1, but the emulsion was injected subcutaneously.

TABLE 2.

Donor.		Recipient.			
D.O.B. No. of Sheep.	Remarks.	D.O.B. No. of Sheep.	Method.	Result.	Remarks.
20826	Jugular: *Rickettsia* rare; small compact groups of medium-sized granules	31039	sc.	No reaction....	Immunity test: Susceptible to heartwater.
		31708	sc.	No reaction...	Immunity test: Susceptible to heartwater.
		31107	sc.	No reaction....	Immunity test: Susceptible to heartwater.
		32106	sc.	Died from heartwater	Jugular: *Rickettsia* not frequent; groups of small to moderate size, consisting of single and multiply granules—almost purele large ring forms.

NOTE.—sc. indicates subcutaneous inoculation.

Results.—Of the four sheep only one reacted to heartwater, and it died. The remainder showed no reaction, although subsequent immunity tests proved their susceptibility. Note that from the same donor (20826) two sheep were injected intravenously and neither reacted (see Table 1).

Comment.—The possibility of artificial transmission of heartwater by the subcutaneous route has been proved by Du Toit, De Kock, and Mitchell,* using blood. They obtained four positive reactions among 16 injected sheep. The method appears to have little practical significance.

* The experiments are published by Alexander, R.A., 1931, on pp. 135 and 136 of the article cited in references.

The above experimental work formed a small portion of the much larger programme which was undertaken, but since chiefly negative findings accrued it is not intended to publish the results in detail. Briefly the inquiry concerned itself with the following additional problems.

1. *Does a toxin play any part in the pathogenesis of heartwater?* Experiments were undertaken where large quantities of blood were transfused or serum injected into susceptible animals from sheep at the height of the heartwater reaction, in the hope that toxic symptoms might be manifested within a time much shorter than the incubation period of the disease. The first sheep (D.O.B. 32151) so treated received 400 c.cm. serum, died within 24 hours of injection, and at post-mortem presented lesions compatible with heartwater (marked general cyanosis, marked hydrothorax, slight hydropericardium, marked pulmonary oedema, gelatinous infiltration of the mediastinum, and slight *tumor splenis*). But as this result could not be again obtained on repetition of the procedure, it was concluded that death should be ascribed to shock, the lesions, of course, being no more typical of this condition than of heartwater.

2. It has previously been noted (Jackson 1931) that the *Rickettsia* shows considerable variation not only in—

(*a*) the size of the groups [Cowdry (1926 *b*, *d*,)]; but also in

(*b*) the size of the granules: These can roughly be divided into small (coccoid), medium, and large, but intermediate stages exist. However, the contrast between the small and the large forms is very striking;

(*c*) the shape of the granules—varying from coccoid to ring or horseshoe forms. Here again the position is complicated by the occurrence of very pleomorphic forms;

(*d*) the frequency of occurrence in the tissues;

(*e*) the distribution (large veins, brain, kidney, etc.).

Have these factors as determined in donors from which either blood or endothelium is injeeted any influence on the Rickettsia *appearing in the reeipients?*

3. *Have such factors an influcnee on the incubation period, severity of reaetion, symptoms, or post-mortem lesions?*

4. *Can any generalisations be formulated as to the distribution of* Rickettsiae *in different subjeets?*

The first question having been disposed of, queries 2, 3, and 4 may conveniently be dealt with together.

It may be said at once that aside from the value of the negative results little of advantage emerged from these investigations beyond the observation of occasional *Rickettsiae* exhibiting characteristics which appeared to have a bearing on the mode of growth of these organisms and which offered engaging suggestions for the detection of even a definite " life-cycle " of this parasite.

The remarks in the Tables (1 and 2) given above are typical of the much larger mass of data which was obtained and they suffice to show that no such relationship exists as is suggested in query (2). A glance will show that the form, group-size, granule-size, and frequency of *Rickettsiae* in the recipients were quite unpredictable from a knowledge of the same factors in the donors.

In all experimental cases as well as in the large number of animals which from the period 24.3.30 to date have been subjected with fatal results to the routine diagnostic blood subinoculation, careful observations were made on the occurrence of *Rickettsia* in sections of brain (hippocampus, cerebrum, cerebellum), kidney, spleen, and often liver and lung as well, while intima smears from the heart and large veins, and organ and bone-marrow smears were also included in the study. Among such observations the following are worthy of mention.

The occurrence of single intracellular *Rickettsiae* is hitherto unrecorded. Several such examples were seen in the intima smears (see Fig. 1). These single bodies were easily identified by their characteristic shape (ring, horseshoe, or comma forms), the presence of a distinct halo, and the typical reaction to the Giemsa stain. Sometimes two or more such forms occurred in a single cell, widely separated in the cytoplasm thereof, and indicative of a double or multiple infection of the cell. (Fig. 2.)

Other examples of *Rickettsia* were found definitely suggestive of budding or multiple simple division. In rare cases horseshoe forms were found showing a multiple transverse fragmentation of the chromatoid material. It is hoped to publish details of this multiplication at a later date.

It was somewhat disappointing that few generalizations could be formulated on the basis of these observations. It is true that in all cases of the single intracellular bodies the large forms showing a definite morphology were concerned. While it must be remembered that such single forms involving the small coccoid type might well be not recognized as *Rickettsiae* and so overlooked, the conclusion was warranted that at least some of the *Rickettsiae* first appearing in the endothelial cells are large ring-, horseshoe-, or comma-shaped bodies, and the inference is that these are at any rate *among* the forms which invade from the blood. This fact was kept constantly in mind in the subsequent examination for *Rickettsia* in blood smears and proved of great value, as will be described below.

The hope of positive answers to queries (2) and (3) above was, however, definitely abandoned on repeatedly finding cases (e.g. sheep D.O.B. 31461, Table 1), where in intima smears *Rickettsia* groups of of all sizes (from a single organism to large groups causing great distension of the cells), having granules of all sizes (small, medium, large) and shapes (coccoid, rings) were demonstrable in one and the same subject. While the possibility of establishing on morphological grounds the existence of a more or less definite "life-cycle" is by no means ruled out, it was at least apparent that in the different cells of the same subject all stages in such a cycle may be represented at any given moment.

It becomes in consequence a matter of extreme difficulty to judge which groups represent earlier stages and which subsequent stages on any basis except the obvious criterion of group-size.

Even in this respect difficulties occur, such as that among animals dead from heartwater some will show a preponderance of small, compact groups of *Rickettsiae*, no large groups causing any noteworthy distension of the cells being visible; while in others small groups may be very difficult to find and the large, distending groups dominate the picture.

In connection with (4) above, it was found impossible to arrive at any general conclusions regarding distribution, frequeucy, and localization, except that—

(*a*) as already indicated by one of us [Jackson (1931)] of intima smears those prepared from the jugular are the most constant seat of *Rickettsiae* and compare favourably with organ sections in this respect;

(*b*) *Rickettsia* was not more frequent in the brains of animals in which, before death, nervous symptoms had beeu pronounced;

(*c*) in general when *Rickettsia* is frequent in one organ (e.g. brain) or vessel (e.g. jugular) it is also frequent in other parts (kidney, heart). Often, however, *Rickettsia*, not detectable, e.g. in the kidney, is easily found in the brain; or is absent from the organs while being easily demonstrable in the vessels; or (rarely) cannot be found in the intima smears but is present in sections.

(*d*) the following heterogenous observations are of interest in regard to distribution:—

(i) *Spleen.*—*Rickettsia* has been seen occasionally in spleen smears. Two such cases were bovine smears sent in for routine diagnosis. In one *Rickettsia* was easily detected and was frequent in the eudothelial cells, in spite of the usual poor standard of preparation and moderate decomposition. In the other (31305-19.3.32), which showed advanced decomposition, the prolonged search (undertaken because an apparent vacuolation of an endothelial cell had aroused suspicion) disclosed the presence of very rare *Rickettsia* groups almost completely bleached, but recognisable by the characteristic shape of the granules. Lest such diagnoses should give rise to the misapprehension that spleen smears are suitable preparations for the routine diagnosis of heartwater, it must be emphasized that it is only by a lucky chance that the disease can be diagnosed in this way: The endothelial content of spleen smears is most inconstant, as is also the occurrence of *Rickettsiae* in the spleen.

(ii) *Liver.*—In one case *Rickettsia* was seen in a section of liver. Only a single group could be found and was in the endothelium of a fair-sized blood-vessel. In no case have we been able to demonstrate *Rickettsiae* in the intralobular capillaries, i.e. in Kupffer cells, and it is apparent that such cells either constitute an unsuitable medium which would be shunned by passing *Rickettsiae* or otherwise their phagocytic powers render *Rickettsiae* a rapidly digested prey.

(iii) *Lung.*—The finding of the *Rickettsia* in the lung has already been recorded by Jackson (1931), but this observation is rather rare and here again the representation of the reticulo-endothelial system in this organ is suggestive.

(iv) *Lymph nodes.*—*Rickettsia* was detected in one case in a haemolymph node (sheep 31912).

(v) *Bone-marrow.*—Examination of a large number of bone-marrow smears failed to disclose the presence of *Rickettsia* in this organ.

(vi) *Histological lesions.*—Steck (1928) has described leucostasis and perivascular cellulation, especially in the liver and the kidney. This has been confirmed by Daubney (1930), who has observed further the presence of neurone satellism. That all these lesions occur in heartwater we do not question, but we must emphasize that it is extremely doubtful whether any one of them is especially characteristic of the disease, and without question they are not of constant occurrence.

The number of round cells present in Glisson's capsule in clinically healthy sheep is strikingly variable as is also the occurrence of round cells in the interstitium of the kidney. In regard to the latter it is not uncommon to observe, in kidneys which were doubtless healthy, cortical, interstitial, round cell accumulations of such prominence as would lead to a histo-pathological diagnosis of interstitial lymphocytic nephritis were it not for the absence of confirmatory evidence (circulatory, degenerative changes).

Research into the cellulation of the interstitium of several organs (notably liver and kidney) is an urgent necessity in veterinary histology. The importance of a closer acquaintance with the normal cannot be sufficiently emphasized.

In regard to the " leucostasis ", Steck considers that the cells concerned are macrophages. With this we fully agree. This being the case, the term used appears to be a most unfortunate one, and is indeed symptomatic of the general confusion which exists on the question of the agranulocytes of the blood. We believe that the macrophage, at least of ruminants, is clearly distinguishable on morphological grounds from the most closely similar agranulocyte, i.e. the monocyte. The nuclear chromatin pattern, the character of the cytoplasm, and the reaction to Romanovsky stains stand in such distinct contrast that it is not even necessary to resort to supravital

staining to distinguish between the two. Recent studies in supravital staining by Forkner (1929, 1930) as well as by Cunningham, Sabin, and Doan (1925), and Sabin and Doan (1927) indicate clearly the necessity of discriminating between the monocytes and the clasmatocytes (macrophages).

The macrophage may form a prominent part of the blood-picture of heartwater, although Steck has not mentioned this phenomenon in his work on the differential count. Typical large macrophages in the blood are illustrated in Figs. 9 and 10.

We have not yet made systematic differential counts where macrophages appear in the circulation since a property of these cells, whereby they cling to the slide used for drawing the smear and in consequence even in the most carefully prepared smears accumulate at the edges and especially at the " distal " extremity, in our experience renders rather unreliable any attempt at accurate relative enumeration; but it would seem that at times these abnormal constituents of the blood may be present in numbers somewhere between 20 and 35 per cent. of the total white count. It is probable that these cells are desquamated from the reticulo-endothelium and that they appear in the blood in response to an anaemia which frequently occurs in heartwater. As they are, however, not normal blood constituents the term leucostasis as applied to their presence in the capillaries gives a false impression. It is not a stasis but a catarrh which gives rise to the lesion in question, and the cells concerned are not leucocytes but macrophages, whose possible conversion into leucocytes (monocytes)—which Steck seems to assume—remains to be proved even in animals in whose haematology we have advanced very much further than in the case of ruminants. Forkner (1930) in a complete statement of the genetic relations of the monocyte, while allowing their transformation into free macrophages does not indicate that this transformation is reversible.

DISCUSSION.

A number of different hypotheses regarding the aetiology and pathogenesis of heartwater have been considered by the authors. They may be grouped as follows:—

I. The " virus " is not present in the blood.

II. The " virus " is present in the blood, but—

- (*a*) is an invisible virus distinct from the *Rickettsia*;
- (*b*) is an ultravisible stage of the *Rickettsia*;
- (*c*) is identical with the *Rickettsia* and occurs—
    - (1) in large clumps attached to the corpuscles;
    - (2) in cells which are pathological constituents of the blood;
    - (3) free and singly and in minute numbers.

These will be examined in some detail.

I. *The " virus " not being present in the circulating blood, the difficulties of reconciling " virus " and* Rickettsia *disappear.*

The idea underlying this is that, although blood as ordinarily drawn (by means of trochar and canula, or large needle) is known to be infective, there is no direct proof that the virus circulates in the blood. It might be present merely in contaminating endothelial cells. It is by no means uncommon to find endothelial cells in blood smears. In our experience, when such cells are seen, it is usually possible to demonstrate their presence in actual sheets, indicative that they constitute artefacts which contaminate the blood as it is drawn off. At first sight the theory is not at all convincing. It derives a certain measure of support from the fact that if *Rickettsiae* are present in the blood, they must apparently occur very sparsely, viz., with a rarity comparable with that of contaminating cells. If endothelial contaminants are difficult of demonstration, then, remembering the small proportion of endothelials which are actually infected, it would be so difficult to demonstrate infected cells in the blood that their apparent absence would carry little weight. We have indeed actually seen infected endothelial cells in blood smears made at post-mortem by lay assistants, but these were unhesitatingly dismissed as contaminants where large sheets of endothelium were also present. In these cases likelihood of actual scraping by the slide of the exposed surface of a large vessel was admitted by the assistant who made the preparations. In other cases the endothelials lay singly and were of rare occurrence (see Fig. 14). Here the probability of post-mortem " desquamation " was assumed. We could not find such cells in blood drawn from living animals.

However, the rarity of endothelium in drawn blood and the very low proportion of infected cells does not appear compatible with the relatively constant results of blood subinoculations, especially in view of the fact that when large amounts of blood are drawn from a single venous puncture into a number of separate containers, blood from all the containers is equally certain to prove infective. The hypothesis was, therefore, dismissed as a very strained attempt to account for the facts.

However, the reflections to which it gave rise should have no little interest for workers who attempt to prove the presence of endothelials in circulating blood by examination of blood smears, without taking what might be considered adequate precautions to exclude or reduce the possibility of contamination.

II. (*a*) *Heartwater is caused by an invisible virus distinct from* Rickettsia, *the* Rickettsia *being not the actual cause but a constantly associated phenomenon of the nature of a " cell-symptom."*

This theory finds some measure of support in the inability of previous workers to demonstrate *Rickettsiae* in the blood in spite of the known infectivity of the latter, and that hitherto no method has been available for proving that the injection of the supposed causal organism (*Rickettsia*) itself would set up the disease.

Against this view the following objections may be urged—

(i) the size of the particulate units of the virus as indicated by filtration experiments should lie within the limit of microscopic vision and, therefore, although the virus may be difficult to find, it is unlikely that it is in fact ultra-visible.

(ii) inclusion bodies, etc., which are considered to be "cell symptoms" show a strict and very characteristic cell specificity. That such bodies should appear in cells so widely different in function, origin, and environment as the epithelium of the arthropod vector and the endothelium of the mammalian host is so opposed to what obtains in the case of inclusion bodies in general as to be well-nigh inconceivable;

(iii) the *Rickettsia* shows all the indications of active growth and multiplication in infected cells. Cowdry (1926 D) has seen what he interprets as their actual discharge into the circulation. This is dealt with more fully below;

(iv) the infectivity of endothelial cells reported above is an insuperable objection. The theory would have to postulate a plurality of causes (viz., *Rickettsia* and a virus) quite unsound as a general biological principle. This theory is, therefore, regarded as unquestionably untenable.

(*b*) *The virus in the blood is an ultravisible stage of the* Rickettsia.

This hypothesis is not necessarily distinct from, e.g. (*c*) (1) and (2) above, but is conveniently treated separately. It suggests itself very readily when an attempt is made to correlate the infectivity of the blood with the (apparent) absence of *Rickettsiae* from the blood. It is an easy way out of the difficulty and is conveniently not susceptible of any direct proof, but rather depends for its verification on the exclusion of all other possibilities.

Similar theories of a transmutation of visible into ultravisible parasites have from time to time been advanced to account for the behaviour of even such pathogenic organisms as bacteria and spirochaetes [see for example Nicolle (1931)]. The view is a somewhat dangerous one inasmuch as, once admitted to hold for one organism, there seems to be no reason why it should not be extended to cover similar difficulties in regard to any other organism. In this connection we have in mind cases of apparent absence of such parasites as piroplasms and trypanosomes from blood which will transmit the infection with certainty providing a sufficient quantity be injected.

The difficulty of demonstrating visible parasites in the blood is far less remarkable in the case of heartwater than in the case of such protozoal diseases. The task of identifying these pathogenic protozoa is, of course, not comparable with the extreme difficulty of detecting a single *Rickettsia* granule. A further weighty objection is that the non-filterability of an invisible virus has to be explained as a mere coincidence—by no means a convincing method of disposing of so peculiar a phenomenon.

Additional objections will appear as the argument proceeds. Among them the occurrence of single *Rickettsia* granules (Figs. 1 and 2) as the earliest stages infecting the endothelium from the blood is suggestive, although it may be contended that the observation proves very little.

(c) (1) *The virus is present in the blood and occurs in clumps attached to the corpuscles.*

This hypothesis is constructed on the views of Alexander (1931), who advances (p. 95) " a tentative assumption . . . that the virus is not evenly distributed in the blood ", and concludes (p. 98) that " the virus appears to be attached to the erythrocytes and leucocytes . . . . " It attempts to account for the following observations:—

(*a*) The blood is infective.

(*b*) The virus does not pass Berkefeld W candles or the Seitz filter.

(*c*) The injection of the serum or plasma (obtained by prolonged centrifuging) causes no reaction in susceptible animals, but the injection of either red or white corpuscles which have been repeatedly washed is followed by positive results.

(*d*) The virus content of the blood is apparently variable as judged by transmission experiments, in which, while the injection of even 10 c.cm. cannot be relied upon to set up infection in all cases, the use of a small amount as 0·1 c.cm. has given positive results.

On this theory, which is tentatively advanced and which deserves close consideration, the following comments may be made:

As indicated above, the presence of the virus in the blood may be accepted without hesitation. Further, the filtration experiments make it plausible that the particles of the virus lie within the limit of microscopic vision.

Although the experiments which are quoted by this author and which had as their object the determination of the localization of the " virus " have admittedly some weight, such tests, notoriously unreliable as they are reputed to be, must be submitted to close scrutiny when they appear inconsistent with the more reliable direct (i.e. visual) observations. To the interpretations placed on these experiments objections that may be urged include:—

(i) The conclusion that the virus resides in the corpuscles and not in the plasma is scarcely justified from the observation that after prolonged centrifuging the former and not the latter appears to carry the infection. The results of the centrifuging may be taken to indicate nothing more than an approximate coincidence in specific gravity of corpuscles and " virus ", which causes them to be precipitated in the same layer.

(ii) The failure to remove the infectivity of the corpuscles by repeated washing is admittedly considerably harder to explain away. It is possible that after precipitation the " virus " exhibits adhesive properties in virtue of which it becomes entangled with or attached to the other elements of the precipitate. In this connection may be recalled the well-known clumping properties of blood platelets and adhesive properties of erythrocytes (rouleaux). Judging by the appearance of *Rickettsia* in smears both of ticks and of endothelium, the intra-

cellular bodies possess great resistance to dispersal under the influence of mechanical traction. This phenomenon is probably to be explained by an adhesive property which might well manifest itself again on concentration by centrifugalization. An alternative explanation may be sought on the lines of the adsorption phenomenon known to be exhibited by certain viruses following changes in the medium. The subject of the attachment of *Rickettsiae* to the corpuscles is further discussed below under " Haematological Observations."

(iii) While failure to demonstrate *Rickettsia* on microscopic examination of the blood may be most plausibly accounted for by the assumption that isolated *Rickettsiae* or even *Rickettsiae* in very small clumps would be very hard to identify with certainty, it is difficult to believe that large clumps would escape notice during examination of many hundreds of blood smears.

(iv) If, in addition to the circumstance that *Rickettsiae* occurred in the blood in clumps, one has also the clue that they are to be searched for in the corpuscles, it is unthinkable that, even though of rare occurrence, such clumps should never have been seen in such a position during the extensive smear examination carried out not only by such workers as Cowdry (1926 B), Du Toit (personally communicated), and Alexander (personally communicated), but also by ourselves.

Prompted by the views of Alexander (1931) we have made smears from the precipitate of infected blood, but have been unable to find *Rickettsia* clumps attached to either the erythrocytes or leucocytes. Even were the clumps of the virus to be for some peculiar reason unstainable by ordinary methods, one would expect their presence in cellular elements to have been detected, or at least suspected, by reason of some such feature as an apparent vacuolation or a distension of the cytoplasm of the infected cells.

(v) From the illustrations published by Cowdry (1926 D) it would seem that on rupture of the endothelial cells the *Rickettsia* clumps are not extravasated *in toto*, but either singly or in minute groups. It may be remarked that these illustrations, which, not photographic, are rather lacking in realism. No one who has carefully observed *Rickettsiae* in intima smears or even in sections could conclude that the bodies illustrated in that article are much more than diagrammatically ilustrated. Their entire lack of pleomorphism is somewhat incongruous with huge magnification depicted by the artist.

It would appear that until this hypothesis can satisfactorily answer the above objections, it cannot be regarded as representing the truth, although it is a valuable attempt to account for the admittedly complex and often apparently inconsistent facts which complicate the problem of heartwater.

(*c*) (2) *The* Rickettsia *occurs in cells which are not constituents of healthy blood.*

Reference has been made above to the occurrence of macrophages in the blood in cases of heartwater, and to their undoubted identity with the cells described by Steck (1928) as taking part in the " leucostasis " in certain organs. Our views on the constancy of the occurrence of leucostasis have also been mentioned. In the blood also the macrophages are not at all constant. In those cases where they were present they could usually be definitely associated with an anaemia; anisocytosis, polychromasia, and Jolly bodies were nearly always present, the latter often in considerable numbers. We concluded that the granular material so often to be found in these cells represented nothing but the debris of phagocyted material although one could often imagine a certain superficial resemblance to *Rickettsiae* (Figs. 10 and 11). It is not excluded, however, that of this debris certain granules may have resulted from the phagocytosis of *Rickettsiae*. These cells could be found also in animals not infected with heartwater.

Certain cells (e.g. Figs. 12 and 13) found in blood smears gave rise to considerable difficulty. These cells contain undoubted *Rickettsiae*, but we could not be certain whether they are true macrophages identical in derivation with the large macrophages illustrated in Figs. 9 and 10, or cells desquamated during life from the general endothelium and modified in shape after having been set free, or ordinary epithelial cells appearing in the blood smears either as contaminants or cells desquamated post-mortem from the endothelium. The question is left open for the present. Should the first alternative prove true, the theory of Alexander (1931) mentioned above would be partially vindicated; but in any case these cells are not leucocytes in the commonly accepted sense.

Among other cells which might be considered as abnormal constituents of the blood (but not as artefacts appearing in the drawn blood) the endothelials have been considered. The question of the presence of these cells in the circulating blood still appears to be unsettled. Some authors, e.g. Sabin and Doan (1926), consider endothelials (i.e. derived from the ordinary endothelium as well as the reticulo-endothelium), to be normal constituents of the blood of certain species at least, and it was thought possible that such desquamated cells carrying the *Rickettsia* might be present even in increased numbers in cases of heartwater. However, as indicated above we have not yet found endothelials (apart from clasmatocytes derived from the specific endothelia) in blood smears of ruminants, except in such circumstances that their presence could reasonably be considered as an artefact, nor are such cells mentioned in the literature dealing with the morphological haematology of ruminants, viz., Du Toit (1916), Schantz (1920), Canham (1930). It is intended to deal with the question of " desquamated endothelials " in a later article.

(*c*) (3) *The* Rickettsia *occurs free in the blood plasma and as single granules.* Of the various hypotheses we considered this to be the far most likely in view of the following evidence:—

(i) The mode of spread of the "virus."—It is, of course, clear that the "virus" spreads by the blood since the blood is infective and since heartwater is obviously a disease characterized by unmistakable septicaemia. But it did not appear to follow from this alone that *Rickettsiae* are spread by the blood stream, although for this there was strong evidence, including the observation by Cowdry (1926 D), of the discharge of *Rickettsiae*, and the impression to be obtained from examination of sections and even of intima smears that the *Rickettsiae* do not tend to occur in contiguous cells of the endothelium. This point appeared so important that a convincing verification was undertaken as follows:

From the jugular veins of sheep dead from heartwater the valves were dissected out, stretched on slides, allowed to dry around their edges, fixed in absolute alcohol, stained by Giemsa, dried and mounted in balsam. Eespecially towards their free borders, the valves are thin enough to permit of ready recognition of cytological details, although for diagnostic purposes the value of the method is not comparable with that of smears. *Rickettsiae* were by no means frequent in such preparations, but it could easily be demonstrated that the distribution had no tendency to involve cells lying in contiguity with infected cells. On the contrary one was impressed by the apparently haphazard occurrence of *Rickettsia* groups occupying one cell here and there.

(ii) The difficulty of finding the *Rickettsia* in the blood favours the view that if the "virus" be not ultravisible it must occur in small particles.

The only objections that can be urged are the results of centrifugalisation and washing (which are answered above), and that hitherto *Rickettsiae* had not actually been demonstrated in blood smears or even a suspicion of their detection expressed. It remained to be seen what could be done towards replying to this remaining objection.

HAEMATOLOGICAL OBSERVATIONS.

We have, therefore, examined a large number of blood smears and have been able to demonstrate (Figs. 3 to 7) the presence of very rare, ring- or horseshoe-shaped bodies, lying singly in the blood, and corresponding in size and general appearance with those to be seen in the endothelium of large blood-vessels. These bodies should be compared with the intracellular *Rickettsiae*, which have been illustrated by Jackson (1931), also with those in Fig. 2. On close scrutiny it will be seen that in most cases the apparently ring-shaped forms are really horseshoe-shaped, and the extremities of the arms of the horseshoe, while lying very close to or even touching each other, are not continuous. This feature is characteristic of many typical intracellular *Rickettsiae*. Figs. 6, 3 and 4 and 5 (taken in the sequence mentioned) show a graded series from the obvious horseshoe- (comma- or open ring-) shape to the almost completely closed

ring-shape. A complete ring-shape is shown in Fig. 8, which depicts a single *Rickettsia* in a spleen smear. In this case it is, of course, not possible to say whether the body in question was originally extracellular or whether it was drawn out of a cell in making the smear; a group of intracellular *Rickettsiae* lay in close proximity to it.

We realized that the coccoid type of granule would be impossible of recognition when lying singly in the plasma, but were of opinion that the ring-shaped forms offer a real chance of identifying single extracellular *Rickettsiae* with reasonable certainty. Unfortunately these bodies in the blood do not appear to have retained their haloes (chromophobic substance)—structures which are so great an aid in the recognition of intracellular forms. It will be admitted that their morphology, the sparsity with which they occur, and the fact that they lie singly are extremely suggestive. We have formed the opinion that they are indeed *R. ruminantium*. Pragmatically, this point of view is decidedly appropriate.

These bodies (Figs. 3, 4, 5, and 6) appear to lie on the erythrocytes, and two questions arise in this connection.

(*a*) Are they attached to the red cells or are they free in the plasma?

(*b*) If they be attached to the red cells, has this cohesion taken place prior or subsequent to the shedding of the blood? In other words, is their association with the cells merely an artefact?

At present we have no final evidence which enables a conclusion to be reached. The disposition of the two *Rickettsiae* illustrated in Fig. 8 might have been of considerable value in the decision of this issue: It might readily be appreciated that this pair of bodies must originally have been free-lying in the plasma, since each component lies on a different erythrocyte. However, it seems probable that the extracellular location of these bodies is an artefact. They occur in a preparation from the same animal (Sheep 32308) from which the cells shown in Figs. 12, 13, and 14 were obtained, i.e. in these blood smears definite intracellular *Rickettsiae* occur. Thus the possibility cannot be excluded that the bodies in Fig. 8 have been forced out of cells in the drawing of the smear. It is for this reason that we hesitate to use them as evidence.

Our opinion is that the single granules found in the blood smear represent originally free-lying bodies in the plasma, and that they are either merely lying loose on the erythrocytes or that their attachment to the cells has taken place during precipitation from the plasma of the formed elements when the slide was prepared. This latter probability is in line with the discussion of the results of the centrifuging of infected blood (*supra*). The appearance of certain particles precipitated from the stain, especially when the May-Grünewald Giemsa combination is employed, is very similar in regard to the apparent relation (i.e. loose superimposition) to the red cells. It may here be pointed out that such particles have often a considerable superficial resemblance to the bodies which we take to be *Rickettsiae*. However, they stain more intensely (almost black) and, where a ring-form is simulated, the clear area is smaller and

the circumference always unequivocably a continuous band. We make these remarks in order to emphasize what we readily admit to be an extreme difficulty in the identification of the bodies under discussion. It is, of course, obvious that the finding of *Rickettsiae* in the blood has no application whatever in practical diagnosis; but for those interested in the problem who may attempt to repeat such haematological observations on heartwater we would remark that the question of identification of the single *Rickettsia* is of an order of subtlety even greater than, e.g. the discrimination between anaplasms and Jolly bodies—a morphological distinction which in spite of the extensive experience of many South African workers is still far from being universally approved. The distinction of these bodies from artefacts and even from Jolly bodies being difficult, we are fully expectant that the discriminations which we have claimed possible of attainment as a result of intensive experience in these observations are likely to be criticised on the lines anticipated above.

It may still be urged that, granting the identity of these bodies with *Rickettsiae*, they may be forms which have recently been discharged from or which are ready to invade the endothelium and are soon to be transformed into or have recently been derived from an ultravisible virus. The question does not appear to be susceptible of any direct proof, but our views as to the probabilities have been outlined above.

CONCLUSION.

Correlating the facts implied by this view with those previously established, the pathogenesis of heartwater may be briefly outlined as follows. *Rickettsiae* injected artificially or naturally are carried along in the blood stream until here and there they find opportunity of entering endothelial cells. Such entry would be favoured by a slow rate of flow such as obtains in the capillaries and also in the larger veins. Of the latter it is interesting that the jugular is so rich and constant in its content of *Rickettsia*. The slow rate of flow in this vessel is associated with the grazing habits of herbivorous animals and is indicated by the liberal supply of valves. Once in the cell a *Rickettsia* increases from a single granule to a large group until the cell ruptures under the distension and the *Rickettsiae* are discharged into the blood stream, the groups being at the same time broken up into their constituents, and the cycle is repeated. The absence of *Rickettsia* from certain organs (e.g. liver), may be associated with the phagocytic activity of the reticulo-endothelium. The difficulty of demonstrating *Rickettsiae* in the blood smears is to be ascribed to the impossibility of recognizing any but those forms which have a very characteristic shape, and also to their sparcity. No one who has searched the tissues for *Rickettsiae* can doubt that on their discharge into the circulation their dilution in the blood must be very small and may indeed be judged from the large amount of blood necessary to be used to ensure constancy in artificial transmission (ca. 5 c.cm., which might contain but one or two individual organisms).

SUMMARY.

1. Heartwater may be set up by the injection of endothelial cells containing *R. ruminantium*.

2. Some observation on the distribution and disposition of the *Rickettsia* are included, which appear to have a bearing on the life cycle of the organism and the pathogenesis of the disease.

3. The possible theories as to the aetiology of heartwater are reviewed.

4. Bodies agreeing morphologically with *R. ruminantium* may be found in blood smears, but with great difficulty.

5. The weight of evidence favours the view that there is no "virus" of heartwater distinct from the *Rickettsia*, but that the latter actually circulates in the blood in the form of single organisms probably lying free in the plasma. Nevertheless, it is difficult finally to exclude the possibility that the *Rickettsia* may have an ultra-visible stage.

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EXPLANATORY NOTE ON PHOTOMICROGRAPHS.

The figures marked 1300× were taken with apochromatic objective 1·5 mm. and compensating ocular 5×, those marked 1600× with the same objective and compensating ocular 7×.

Fixation in absolute alcohol and staining with Giemsa or May-Giemsa.

Fig. 1.—Single *Rickettsia* infection of an endothelial cell. Incomplete ring form. Intima smear made after death from the jugular vein of sheep 31600. 1,300 ×.

Fig. 2.—Double infection of an endothelial cell. Horseshoe forms. Same preparation as Fig. 1. 1,600 ×.

Fig. 3.—Single *Rickettsia* (open ring form) in a blood smear taken post-mortem from Sheep 32134. Note also anisocytosis and two Jolly bodies. 1,300 ×.

Fig. 4.—Single *Rickettsia* (open ring form) in a blood smear from same sheep as Fig. 3. Note anisocytosis. 1,600 ×.

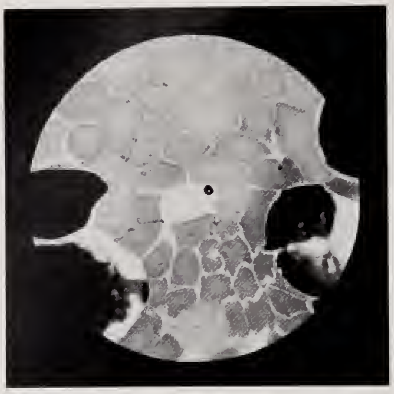

Fig. 5.—Single *Rickettsia* in the blood. Same preparation as Fig. 3. 1,300 ×.

Fig 6. — Single horseshoe - shaped *Rickettsia* in a blood smear. Same sheep as Figs. 3, 4, and 5. 1,600 ×.

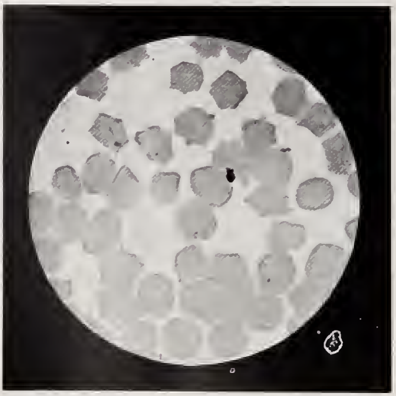

Fig. 7.—Group of two *Rickettsiae* in a blood smear made post-mortem from Sheep 32308. 1,300 ×.

Fig. 8.—Single extracellular (?) *Rickettsia* in a spleen smear. Sheep 31461. 1,300 ×.

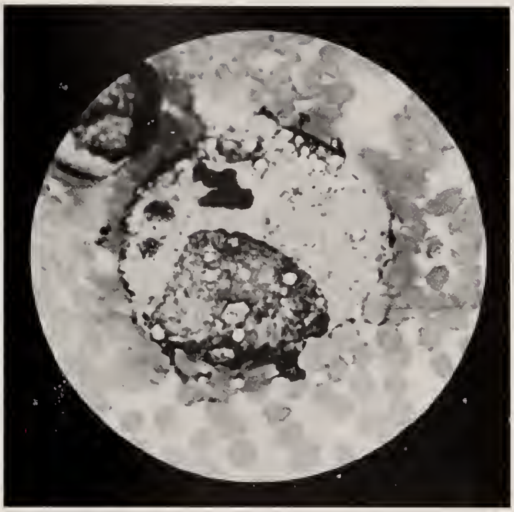

Fig. 9.—Typical macrophage with vacuoles and phagocyted inclusions in the blood of Sheep 32331. 1,300 ×.

Fig. 10.—Two macrophages in the blood of Sheep 32331, one containing a phagocyted erythrocyte and granules having a superficial resemblance to *Rickettsiae*. 1,300 ×.

Fig. 11.—Macrophage in the blood of Sheep 32331 with phagocyted inclusions having a close superficial resemblance to a group of *Rickettsiae*. 1,300 ×.

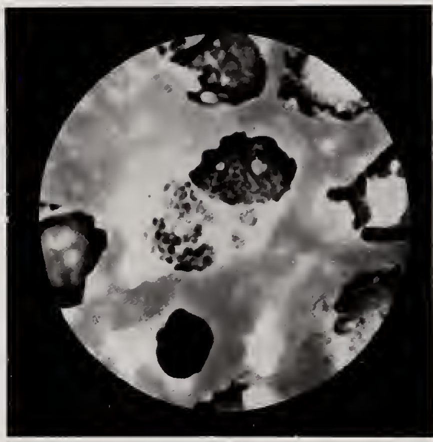

Fig. 12.—Infected cell in a blood smear (post mortal) of Sheep 32308. Probably this cell was desquamated from the endothelium after death. 1,300 ×.

Fig. 13.—Small *Rickettsia* group and a pigment granule in a cell considered to be either a macrophage or a distorted endothelial. Same preparation as Fig. 12. 1,300 ×.

Fig. 14.—*Rickettsiae* in a cell found in a blood smear of Sheep 32308. This is a typical endothelial—either an artificial contaminant or was desquamated post-mortem into the blood. 1,300 ×.

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

Rabies as it occurs in the Union of South Africa.

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RABIES in South Africa has occupied the attention of the authorities both veterinary and medical for over a century. Since 1893, when a serious outbreak occurred at Port Elizabeth, until November, 1928, no case of Rabies was established biologically or histologically in the Union. Early in the present century the disease was prevalent in Southern Rhodesia. In Portuguese East Africa and in South-West Africa, it has never been diagnosed, although vague reports of suspicious cases have been received from the latter territory.

HISTORY OF RABIES IN SOUTH AFRICA.

In the Journal of the Medical Association of South Africa, May 28th, 1927, Cluver makes mention of reported outbreaks of Rabies prior to those mentioned above. Thunberg in his " Travels " refers to cases in October, 1772. Sir Theophilus Shepstone reported an outbreak in 1828. In 1857 cases were diagnosed in Elmsdale, Natal, when several natives contracted the disease and died. In 1861 in Wittenbergen in the Free State many dogs died and at least one human being died following the bite of a mad dog.

The outbreak in Port Elizabeth in 1893 was traced back to an Airedale terrier imported in September, 1892, which died a few weeks later after having fought with and bitten several other dogs. The diagnosis was finally established clinically and by means of biological tests by Dr. Hutcheon, Dr. Edington and Mr. Borthwick. By means of stringently applied muzzling order, wholesale destruction of ownerless and unlicensed dogs, and strict quarantine, the disease was evidently eradicated. In his report to the Government of the Cape of Good Hope for the year 1893, that keen observer, the late Dr. Duncan Hutcheon, who was Colonial Veterinary Surgeon at the time, mentions his fears with regard to the possibility of the spread of the disease to wild animals, of which he mentions particularly jackals, but, except for a case in an ox at Van Stadens, no cases other than in dogs and cats were observed.

In Southern Rhodesia the disease was first reported in August, 1902, by Charles E. Gray, the Chief Veterinary Officer of the Colony. Hutcheon and Robertson were summoned from the Cape Colony and confirmed the diagnosis. Dr. Loir from the Institute Pasteur in Paris came out to Rhodesia and established a laboratory for the pre-

TABLE 1.

SHOWING THE RECORDED CASES OF HUMAN RABIES IN THE UNION OF SOUTH AFRICA FROM 1916 ONWARDS. ALL THESE CASES WERE FATAL.

Date.	District.	Cases.	Interval between Onset of Symptoms and Death.	Biting Animal.	Site of Bite.	Interval between Bite of Animal and Onset of Symptoms in Patient.
1916	Heilbron, O.F.S.	Two human deaths	—	Mungoose	—	—
Dec. 1920	Frankfort, O.F.S.	European male child (7 years)	2 days	Mungoose	Shoulder(?), finger	6 weeks.
Sep. 1923	Vredefort, O.F.S.	European farmer (27 years)	5 days	Dog	Left fore-arm	12 weeks.
Jan. 1924	Middelburg, Transvaal	Agricultural* (21 years)	6 days	Mungoose	Finger	8 weeks.
Nov. 1925	Bloemfontein, O.F.S.	European male adult	8 days	Dog	Not recorded	5 weeks.
June 1926	Wolmaransstad, Tvl	European boy (7 years)	4 days	Mungoose	Right hand between thumb and first finger	6 weeks.
Sep. 1926	Vryburg, C.P.	Female European child ($3\frac{1}{2}$ years)	3 days	Genet cat.	Throat	$4\frac{1}{2}$ weeks.
Dec. 1926	Ermelo, Tvl	(*a*) Native child (5 years) (*b*) Native woman (about 30)	A few days	Dog	(*a*) Head (*b*) Arm	About a month. Slightly longer.
Feb. 1927	Standerton, Tvl	European boy (9 years)	2 days	(*a*) Dog (*b*) Mungoose	Right arm Thumb	9 weeks. 6 weeks.
Aug. 1928	Bloemfontein, O.F.S.	European boy (7 years)	3 days	Mungoose	Right thumb	6 weeks.
Jan. 1930	Carnarvon, C.P. (Olifantskop)	European male	4 days	Mungoose	Left index finger	3 weeks.
Nov. 1930	Trompsburg, O.F.S., Eensgevonden	European male (20 years)	4 days	Dog	Thumb	4 weeks.
Jan. 1931	Maraisburg, C.P., Karreefontein	European male (12 years)	4 days	Skunk [Mungoose]	Right index finger	6 weeks.

* Student.

paration of the Pasteur vaccine. During the course of the following year cases were reported in wild animals. Reports by Gray and later by Sinclair, who succeeded him, mention the great difficulty experienced in maintaining quarantine restrictions. The existence of the disease in wild animals is given as a further reason for the improbability of eventual eradication. Nevertheless, in spite of these handicaps, the number of reported cases, admittedly only a portion of those which occurred, steadily declined from 1906 onwards. In 1913 a " marked decrease " was reported, and since 1914 there have been no further reports of cases.

In the article mentioned above, Cluver includes a table setting forth a number of cases diagnosed clinically by medical practitioners in the Union during the period 1916 to 1927. None of the cases was confirmed biologically or histologically. By permission of the author, this table is appended. The table is completed by the addition of later cases diagnosed clinically but not confirmed by laboratory examination.

At the Veterinary Research Laboratory at Onderstepoort isolated reports of suspected outbreaks of Rabies in domestic animals have been received from various parts of the Union since 1922. Material sent in for laboratory confirmation was always either too decomposed or derived from animals killed before the disease had run its course. In any case, results of sub-inoculations and microscopic examination were always either negative or uncertain owing to decomposition. The difficulty in getting suitable material was largely due to the fact that cases were rarely reported until human deaths occurred, and by that time the carcase of the original infective animal had become destroyed. Cases of madness in dogs and cats were destroyed without the owners being suspicious of the real cause.

The diagnosis of Rabies in these cases diagnosed clinically by practitioners, and in the cases suspected in animals by farmers was generally questioned. The isolated nature of the cases, the failure of the disease to spread once it made its appearance in spite of the fact that no measures were adopted to counteract the spread, are features peculiar to the disease as it occurs in the Union. It differs markedly in the epizootology from Rabies in other parts of the world, notably Europe and Asia. Clinically and histo-pathologically the identity has been proved beyond doubt.

DIAGNOSIS OF THE FIRST CASES IN THE PRESENT OUTBREAK.

The cases occurred on the farm Cyfergat in the Wolmaransstad District and their history is briefly as follows: A medical practitioner from Klerksdorp, Dr. L. Herzenberg, was called to attend a boy, E——— B———, on the above farm on November 19th, 1928. He diagnosed Hydrophobia and had the patient brought to Klerksdorp Hospital next day, but the patient died en route. On October 30th, two boys, B——— and S———, caught a sick meercat on the way to school and during the day both children were bitten on the fingers. S——— died on the 24th November in the Klerksdorp Hospital. Post-mortem examination was made on both bodies and the brain was sent in a fresh state to the Institute for Medical Research at

Johannesburg. It was due to the prompt action of Dr. Herzenberg in diagnosing the cases, obtaining material in a fresh state and promptly despatching it to the proper quarter that Rabies after much controversy was eventually definitely diagnosed in the Union. The cases were reported by Herzenberg in "The Journal of the Medical Association of South Africa," December 22nd, 1928.

Through the courtesy of Dr. Mitchell, Secretary for Public Health, and Dr. Buchanan of the Institute for Medical Research, brain material for inoculation at Onderstepoort was obtained from both these cases.

Case 1.—Died 20.11.28. Experiment No. S. 3731.

Portions of the cerebellum, cerebral cortex and hippocampus were mashed in sterile normal saline, the emulsion strained through sterilized gauze and injected into animals as indicated in Table 2.

Case 2.—Died 24.11.28. Experiment No. S. 3736.

Four days after the first case the second boy died and material was obtained in the same way.

For further details see Table 2.

The mungoose used were of the species known as Yellow mungoose—*Cynictis penicillata.*

Discussion of Cases 1 and 2.

Since previously reported cases had not been confirmed by biological tests or histological examination, and since reasonable doubt existed as to the actual cause, a variety of animals inoculated in various ways were used, in order to diagnose the cases should the disease prove not to be Rabies. When the Rabbits in Case 1 showed typical symptoms, very little doubt remained as to the disease being Rabies.

Dogs.—Four mongrel dogs were each inoculated subcutaneously with 2·0 c.c. of emulsion of hippocampus, cerebrel cortex and cerebellum of human brain. They were kept under observation for a period of eight months but showed no sign of ill-health. They were then destroyed.

Rabbits.—Ten rabbits were inoculated subdurally. Two died from causes other than Rabies. In the remainder the incubation period varied from eleven days (2 cases R. 11 and R. 12), fourteen days (one case R. 1), sixteen days (3 cases R. 2, R. 3, R. 4), twenty days (one case R. 5) to as much as forty-eight days (one case R. 6). The symptoms observed in the rabbits inoculated subdurally were the well-known typical progressive paralysis of so-called Dumb Rabies. In one case in a rabbit markedly increased sexual appetite was observed. The day preceding the appearance of the paralytic symptoms it was observed for about half an hour during the morning and was seen to copulate with its mate in the cage about twenty times.

In all these cases, with the exception of the first two cases mentioned, Negri bodies could be demonstrated in sections of the hippocampus and cerebellum. Two rabbits were inoculated subcutaneously and both survived after three months. Two rabbits were inoculated intraperitoneally. One died thirty-two days later without showing any visible symptoms. Sections of hippocampus and cerebellum were negative for Rabies.

Month	Biological Tests.					Remarks.
	hod.	Incub. Period in Days.	Duration of Disease in Days.	Symptoms.	Histo-Path. Exam.	
Nov. 19	bc.	—	—	—	—	Survived.
		14	3	Dumb Rab.	Positive	—
	ibd.	11	8	Dumb Rabies	Positive	—
	,,	11	5	,,	,,	—
	—	—	—	—	—	No biol. test carried out.
	—	—	—	—	—	No biol. test carried out.
	—	—	—	—	—	No biol. test carried out.
Nov. 1						
	ibd.	13	5	Dumb Rabies	Positive	—
	,,	13	5	,,	,,	—
il	ibd.	24	4	Dumb Rabies	Susp.	—
	,,	47	3	,,	Negative	—
	,,	—	—	—	—	Died 6 months later.
	,,	76	2	Dumb Rabies	Negative.	—
April	-musc.	21	4	Dumb Rabies	Susp.	—
	,,	—	—	—	—	Died 2 days after injection.
	ibd.	12	3	Dumb Rabies	Positive	—
	,,	12	4	,,	,,	—
June	—	—	—	—	—	Biol. test carried out at Port Elizabeth, which was positive.
Sep. 1	bd.	14	3	Dumb Rabies	Positive	—
	,	14	8	,,	,,	—

s Mungoose.

Guinea-pigs.—Six guinea-pigs were inoculated intraperitoneally with 1·0 c.c. of brain emulsion. All six animals died after periods from twelve to twenty-four days. Sections from the hippocampus of two of these animals G. 1 and G. 7 showed presence of Negri bodies. Material from the others was not examined. Sub-inoculations from G. 1 and G. 7 of brain, spleen and blood subcutaneously and intraperitoneally into other guinea-pigs gave negative results, the animals remaining healthy for over three months.

Mungoose.—Two animals of the species *Cynictis penicillata*, were injected subcutaneously with emulsion from the second case. The first symptoms appeared sixteen and seventeen days respectively after injection. The disease lasted for two days in the first and three days in the second case. When first observed to be ill the animals were dull, eyes staring and the hair over nose and cheeks moist. When approached or disturbed they would jump against the sides of the cage and spit like cats. Occasionally the animals would walk around aimlessly. Their appetite remained voracious during the first day. The periods of dullness increased in intensity and became progressively longer. The gait then was staggering and there was marked inco-ordination of movements. The hair over the anterior half of the body was wet and pasted down. Salivation was marked just before death. For twelve hours before death in one and twenty-four hours in the other, the animals were completely paralysed, paralysis progressing from behind forwards. Sections prepared from the hippocampus and cerebellum showed Negri bodies.

Cats.—Two cats each received 1·0 c.c. brain emulsion from Case 2 subcutaneously. Fifteen days later one animal appeared ill. The eyes were staring and had a glossy appearance. There was marked salivation and frothing at the mouth, twitching of the facial muscles and unsteady gait. On the following day the same symptoms were observed, the gait had become more uncertain, and the animal lay down a good deal, paresis affecting chiefly the hindquarters. The following day paralysis was complete, the breathing shallow. Occasionally the animal spat and made champing movements with the jaws. Death occurred overnight. Sections from the hippocampus and cerebellum showed the presence of a few Negri bodies. The other cat remained healthy.

Case 3.—Died 30.1.29. Experiment No. S. 3806.

A female European child sleeping out of doors at a hamlet, Burgerville, near De Aar, in the Cape Province, was bitten on the neck by a genet cat, *Genetta felina*. A dog tackled the genet cat and killed it after having been bitten on the tail. The child's wounds were attended to and healed rapidly. About a month later having returned to her home at Jacobsdal in the Orange Free State the child died after showing symptoms of Hydrophobia. The brain was despatched to the Medical Research Institute at Johannesburg, and from there half of the brain was obtained for histo-pathological examination at Onderstepoort, where the presence of Negri bodies was demonstrated.

When the report of the case was received instructions were given that the dog mentioned above should be confined. When the animal was traced it had developed gangrene of the tail, portion of which had dropped off. The dog was secured, but later escaped and was shot before symptoms had developed. The head was removed and despatched to Onderstepoort, arriving on the 8th of February, eight days after the death of the child.

Experiment No. S 3806.—Two rabbits, R. 19 and R. 19a, were inoculated subdurally with emulsion prepared in the usual way. In addition, one Suricate (*Suricata suricatta*) and one red mungoose (*Myonax cauui*) were inoculated subcutaneously. The result was entirely negative. All the animals with the exception of the Suricate survived. The last mentioned animal died ten days later and sections proved to be negative for Negri bodies.

Case 4.—Died 28.2.29. Experiment No. S. 3828.

A dog on the farm Blandford near Dealesville in the Boshof District of the Orange Free State was noticed to behave curiously. It had a vacant look, and was snapping and yelping in a peculiar manner. The owner decided to castrate the dog. During or immediately after the operation the owner and a native asisstant were bitten. The animal was tied up, but escaped, bit some pigs and cats, and killed several fowls. It was eventually caught again and confined at the Police Station, Dealesville, to await the arrival of the Veterinary Officer from Bloemfontein. The dog was dead on his arrival and the head was sent to Onderstepoort for diagnosis. Later on two pigs died with symptoms of Rabies. The owner was treated and remained healthy, but the native died from Hydrophobia. The cats had been killed earlier. No further specimens were received from this outbreak. This material proved to be positive for Rabies. (For details see Table 2.)

Case 5.—Died en route 17.4.29. Experiment No. S. 3895.

A sick mungoose (*Cynictis penicillata*) caught at Leeuwdoornsstad a hamlet near the farm Cyfergat where the first two cases occurred was sent to Onderstepoort in a crate by the Police. It was found dead on arrival. Both microscopic examination and biological test from this meercat proved to be positive. (See Table 2.)

Case 7.—Died 5.6.29. Experiment No. S. 3931.

On May 11th, 1929, the owner of a farm, Witdam, near Dealesville, while riding through the veld noticed some oxen milling round something in a camp. On approach he discovered what appeared to be a sick mungoose as the object of the attention. He killed the mungoose, which from his description was a yellow mungoose, with a sjambok after it had bitten one of the oxen on the nose. On May 30th he noticed peculiar behaviour on the part of this animal, i.e. bellowing, viciousness, uncertain gait and salivation. The animal was captured, cast and examined for a foreign body in its throat, but nothing was found. It was then isolated in a camp on account of its viciousness. Death occurred on June 5th, and the head sent to Onderstepoort by the Government Veterinary Officer, Bloemfontein. A positive diagnosis of Rabies was made. (See Table 2.)

Case 16.—18.3.30. Experiment No. S. 4144 and 4171.

A CASE OF ATYPICAL RABIES IN A SURICATE.

A suricate (*Suricata suricatta*) suspected of suffering from Rabies was sent to this Institution by the Government Veterinary Officer at De Aar, from the township of Carnarvon. This animal had become aggressive and bitten a child. On arrival the suricate still showed an aggressive attitude, and was placed in a special cage for observation. The following day it behaved quite normally, and when placed in the sun it would sit on its haunches and gaze around inquisitively. Nothing abnormal was observed until May 4th, more than six weeks later, when it became dull and weak and stopped feeding. The next morning it was found dead in the cage. Histo-pathological examination of the brain proved negative. The biological test, however, was positive. (See Table 2.)

This is a difficult case to explain. Was the suricate suffering from Rabies at the time when the child was bitten? The child was treated immediately with antirabic vaccine and remained healthy. Unfortunately no saliva was collected from this animal to establish the fact. Cases of intermittent rabies have been recorded from time to time in the literature, and it is possible that this atypical case could be described as such.

A similar case was observed in a red mungoose (*Myonax cauui*) artificially infected with Rabies virus by subcutaneous injection. Experiment No. S. 3838. Symptoms of dullness and listlessness alternating with viciousness appeared on the fourteenth day when the animal was allowed to bite a dog No. 708. Five days later the mungoose had apparently recovered. Six days later still, symptoms again appeared and continued for three days when the animal died from Rabies. The dog No. 708 died six months later without any obvious symptoms of Rabies but on histo-pathological examination the presence of typical Negri bodies could be demonstrated in sections from the cerebellum.

Case 26.—3.9.31. Experiment No. S. 4504.

Mr. J. D. Mostert a farmer at Uitzicht, Hoopstad District, noticed that one of his sheep from a flock of 200 was sick at 6 a.m. on September 3rd. The animal was lying down but when approached by man or other sheep, it would suddenly jump up and chase them. Death occurred at 12 a.m. the following day. Brain material was collected and sent in salt for examination. The material was unsuitable for histo-pathological examination. The biological test, however, gave positive results. (See Table 2.)

The above cases recalled in some detail occurred in different species or were transmitted by a different species of animal. The first two cases occurred in human beings, who were reported to have become infected by the bite of *Cynictis penicillata* and a third case also in a human being was transmitted by *Genetta felina*. The fourth case occurred in a dog, the first proved case in a dog since the outbreak at Port Elizabeth diagnosed by Hutcheon in 1893. In the fifth case the disease was proved for the first time in this outbreak in a wild carnivore, and the sixth case occurred in an ox. The fourteenth case mentioned in Table 2 is the first positive case met with in

case of a pepper-and-salt meercat (*Myonax pulverulentus*). The fifteenth case of atypical Rabies is the first proved case in a suricate and the twenty-sixth case, the first positive case in a sheep.

In Table 2 details regarding the number of cases definitely positive for Rabies are given.

A summary of the occurrences in each year is given in the following table. The figures in brackets denote cases diagnosed clinically, where material was not submitted for laboratory confirmation.

TABLE 3.

Year.	Rabies Diagnosed in :	Number of Cases in Transvaal.	Number of Cases in Orange Free State.	Number of Cases in Cape Province.	Total Number of Cases.	Annual Total.
1928	Humans.............	2	(1)	—	2 + (1)	—
	Cynictis penicillata....	2	—	—	2	—
	Mungoose (Species not mentioned).........	—	(1)	—	(1)	—
						4 + (2)
1929	Humans.............	1	1	1	3	
	Dog.................	—	1	—	1	
	Ox..................	—	1	—	1	
	Pig.................	—	2	—	2	
	Cynictis penicillata....	—	5	—	5	
	Genetta felina........	—	2	—	2	
	Mungoose (Species not mentioned).........	1	—	—	1	
						15
1930	Humans.............	1	(1)	(1)	1 + (2)	
	Dog.................	1	(1)	—	1 + (1)	
	Ox..................	—	2	1	3	
	Cynictis penicillata....	—	—	1	1	
	Suricata suricatta.....	—	—	2	2	
	Myonax pulverulentus..	—	—	1	1	
	Mungoose (Species not mentioned).........	—	—	(1)	(1)	
						9 + (4)
1931	Humans.............	—	—	1 + (1)	1 + (1)	
	Dog.................	—	1	—	1	
	Ox..................	—	2	—	2	
	Sheep...............	—	1	—	1	
	Cynictis penicillata....	—	—	1	1	
	Mungoose (Species not mentioned).........	—	—	(1)	(1)	
						6 + (2)

KNOWN CARRIES OF RABIES IN SOUTH AFRICA.

In the cases reported where a wild animal has been concerned in the transmission, only members of the family *Viverridae* have been proved to be carriers of Rabies. Of the other families of wild carni-

vora the skunk has occasionally been mentioned. One such case is mentioned in Table1 and another in Case 20, Table 2. In the latter case the term skunk was used, but on further enquiry it proved to be a yellow mungoose. The Afrikaans term for skunk, namely " muishond " is also sometimes used by farmers for " meerkat " (English " Suricate " and " Mungoose "), e.g. in some parts of the country one hears of " geel muishond " and " rooi muishond ", meaning yellow and red mungoose. Such terms are wrong, as the true " muishond " does not resemble the common mungoose species. It is quite possible, therefore, that the other case about which no further details could be obtained was wrongly reported.

The Viverridae are a large family divided into two sub-families, Viverrinae and Herpestinae, in both of which proved carriers are found. The Yellow Mungoose, the Suricate and the Pepper-and-Salt Meercat belong to the last mentioned, and the Genet Cat to the first-mentioned sub-family.

Captain G. C. Shortridge from the Kaffrarian Museum at Kingwilliamstown was kind enough to give the following information as regards the distribution of the various members of the family Viverradae:—

(1) *Genetta felina* can be considered the most widely distributed of South African genets, being found with geographic variation practically everywhere from the Cape Peninsula to the Zambesi and beyond, except in the extreme coastal forests from about the Kei River northwards, where it is replaced by the allied species *G. trigina.* The genus Genetta is spread throughout Africa and also extends into Spain, Southern France and also in parts of Western Asia, viz., Syria and South-East Persia.

(2) *Cynictis penicillata* occurs in the Uitenhage and the Alexandria division of the Cape (apparently the only point where it reaches the East Coast). It is reported to be plentiful around Port Elizabeth and in certain areas of Kaffraria, and according to Sclater, also in Tembuland. It does not occur in the extreme coastal parts of Kaffraria, the Transkei or Natal, although it approaches the coast in Kaffraria as far as the neighbourhood of Kingwilliamstown. From its most southern distribution it extends through the highveld towards the West Coast. It is widely distributed in the Orange Free State, Griqualand West, the highveld of Transvaal, throughout Bechuanaland as far north as Lake Ngami.

In South-West Africa it occurs from the Orange River through Namaqualand, Damaraland (except the Namib) to the Kaokoveld (as far as Okorosane and in Western Ovamboland and the Etosha Pan area). It is absent in the extreme north-east, i.e. Grootfontein District and the Caprivi Zipfel.

(3) *Suricata suricatta*, has a somewhat similar but more restricted distribution than *Cynictis* in the Cape Province. It is more typically a Karroo animal and does not occur anywhere near Kingwilliamstown or elsewhere in the low coastal grassveld area. It is distributed from Uitenhage and Alexandria division of the Eastern Cape Province (apparently as with *Cynictis*, the only point where it approaches

the east coast). Being essentially a Karroo animal in the Cape Province it does not occur in Kaffraria or anywhere near the east coast north of Keiskama (possibly the Great Fish River). The distribution extends westwards through the Karroo to as far south as Ceres to the Little Namaqualand. Further, it extends northwards across the Orange River, through the Orange Free State to the Natal border, and according to Sclater, in Griqualand East. It also occurs extensively on the South Central (highveld area) of the Transvaal, in Griqualand West and in southern and central Bechuanaland. It occurs extremely localised in South-West Africa in Southern Damaraland as far as Rehoboth and eastwards through Gobabis District to the Bechuanaland border.

(4) *Myonax pulverulentus.*—This species is practically restricted to Africa south of the Orange River, in which area it is widely distributed. It has also been recorded in Griqualand West, where it is apparently, and on one occasion from near Bloemfontein its most northern record.

(5) *Myonax cauui* extends practically as far south as the Orange River, e.g. into Great Namaqualand, the Orange Free State and Natal, as well as Transvaal. In the Eastern Cape Province it extends into Pondoland and probably Transkei.

The Myonax group of mongooses, including allied genera, are distributed through Africa south of the Sahara.

Very often the Cape ground squirrel, which is called the "waaierstert meerkat" in Afrikaans, is mistaken for a true meercat. The ground squirrel (*Geosciurus capensis*) is a rodent. It is very often found living in the same burrows and colonies as the Suricate and the yellow mungoose.

A table giving zoological and vernacular names is appended.

THE DISTRIBUTION OF THE DISEASE.

A series of maps giving the magisterial districts of the Union are appended. In the first the magisterial districts in which Rabies was suspected to have occurred from the years 1916 to 1927 are shaded. The cases have been described by Cluver and are set out in tabular form, Table 1. It will be seen that the supposed infected portion extends in a belt from Ermelo in Eastern Transvaal across the highveld areas of the Southern Transvaal and Northern Free State to Vryburg in Bechuanaland. The subsequent maps, Nos. 2, 3, 4 and 5, show successively the districts in which Rabies occurred in the years 1928 (when the disease was definitely established for the first time) to 1931. The last of the series shows a summary of the occurrences, including those diagnosed clinically but not proved, the latter being cross-shaded.

The maps are naturally incomplete, firstly in that practically only cases occurring in human beings and domestic animals are reported, and secondly, in that these reported cases are only a portion of the cases that do occur. Mad dogs and other animals that behave strangely are frequently destroyed without being reported. This was particularly the case prior to the broadcasting of the results of the

TABLE 4.

Zoological Names.	Number of Known Varieties.	Vernacular Names.								Remarks.
		English.	Afrikaans.	Zulu.	Swazi.	Xosa.	Sotho.	Sepedi.	Sechuana.	
Genetta felina (Fam. Viverridae; Subfamily Viverrinae)	3	Cape small-spotted genet	Muskejaatkat Misseljat kat Muskkat Klein swartgevlekte mosiliaatkat	Insimba	Insimba	Inyawagi	Thsipa	Tehipa	Tsipa	Natural case.
Myonax pulverulentus (*Herpestes pulverulentus*) Subfam. Herpestinae	3	Cape grey mungoose Pepper and salt cat	Klein grys kommetjiekat Neethaar Garkie Klein vaal kommetjiekat	—	Ilitse	—	Moyêwane	—	—	Natural case.
Cynictis penicillata Subfam.: Herpestinae	8	Cape yellow mungoose Bushy-tailed meercat Yellow meercat	Geel meerkat Rooi meerkat Witkwas meerkat Witpuntstert meerkat	—	—	Igola	Mosa Moswê	—	Mushui	Natural case.
Suricata suricatta Subfam.: Herpestinae	5	Cape suricate or meercat Slender-tailed meercat True or common meercat	Stokstert meerkat Graatjie meerkat Gewone meerkat	—	—	—	Letoli	—	—	Natural case.
Myonax cauui (*Herpestes gracilis*) Subfam.: Herpestinae	5	Slender mungoose Ruddy mungoose Red mungoose	Rooi meerkat	Cagiti	—	—	—	Xanu	Kgaru	Infected exper.

investigation of the first cases. The districts that have been shown to be infected extend from Bechuanaland in the North, include the Western portions of the Transvaal and Orange Free State, the Central Karroo to Cradock in the South. This area is included in the area of distribution of the known carriers and comprises roughly, especially in regard to its North-Eastern portion, the area most densely inhabited by the species *Cynictis* and *Suricata*.

The cases of suspected Rabies clinically diagnosed occurred chiefly in the highly developed and relatively densely populated eastern portion of the Transvaal and northern Free State. It is significant that since 1928, when circulars were sent to veterinary and medical officers, magistrates and other officials, and news letters were printed in the Press, only one case has been reported from the Eastern Transvaal, namely, from the Bethal District, in 1930. It is reasonable to suppose that this was the only case in a human being which occurred in these districts during this period, and although there are comparatively few field veterinary officers, it is also unlikely that cases in domestic animals would have escaped notice entirely. Very little doubt can remain that the clinically diagnosed cases were in the majority of instances at least definite cases of Rabies, and one may safely assume that the incidence of the disease in these areas has markedly decreased during the last few years.

On the other hand, the relatively under-developed and sparsely populated central portion, where one can expect cases of Rabies even in human beings to escape the notice of the authorities, has produced the majority of known cases. In this area, furthermore, the southern portion Cradock and Middelburg Districts, are more developed than the northern portion, and the first known cases occurred there in 1930 and 1931. This has bearing on the probable origin of the disease if it is borne in mind that the first proved cases of Rabies occurred in Port Elizabeth in 1893 just south of these districts.

Apart from the cases mentioned in the foregoing paragraphs, no significance can be attached to the distribution as indicated in the maps for successive single years from 1928 to 1931. Their admittedly incomplete nature, owing to the difficulty in obtaining information of incidence makes it impossible to draw conclusions from them in regard to the spread or migration of the disease.

METHODS OF CONTROL.

The nature of the disease as it occurs in South Africa precludes any attempt at eradication, and indeed, a large and expensive campaign against the carriers would not only in all probability fail, but does not appear to be indicated by the number of serious case. By proper publicity to Europeans and natives, the number of human deaths from Rabies can be eliminated almost entirely. Any bite from a wild carnivora or by a domestic one that behaves strangely, should be looked upon as dangerous and treatment must be applied for immediately. Domestic animals that behave abnormally must be destroyed immediately, and their previous movements traced. Where Rabies is known to have occurred, strict control of apparently ownerless and of all unlicensed dogs must be applied. When the facts of the disease have become widely known, that is, once suitable publicity has played its part, the incidence of the disease will diminish to a negligible quantity.

Departmental measures undertaken where outbreaks have occurred apart from controlling dogs, have aimed at decreasing the population of the Viverridae. The colonising habit of these small animals makes the task an exceedingly difficult one. Such colonies measure to 120 yards and more in diameter with burrows every few feet. The majority of these burrows are blind alleys used for escape when danger threatens, but all with the exception of a few have to be closed when destruction by gassing is undertaken. Those temporarily hiding in blind burrows naturally escape destruction. Extermination by gassing with cyanide gas has been undertaken with marked success in most districts where the disease has occurred. Mr. R. J. White, a senior laboratory assistant of this Department, has been in charge of the extermination and has supplied the information in the table given below.

The table shows a list of farms, the size of each farm, the number of colonies and single burrows treated and the amount of gas used. The usual procedure is to close all but a few burrows into which the cartridges are discharged.

The degree of success of this method in the control of Rabies cannot be gauged as sufficient time has not yet elapsed since the campaign was undertaken. Owing to the relatively low incidence it is doubtful whether a very clear indication will be obtained, particularly since recolonisation is fairly rapid. Farmers themselves, however, will no doubt undertake to keep the population of these small carnivora at a much lower level than formerly.

A possible danger also exists in driving the extermination to great lengths as it will no doubt disturb the so-called "balance of nature" leading to a marked increase in the small rodent population. Small rodents being the carriers of the human Bubonic plague, which exists in areas infected with Rabies, will increase, if some of their natural enemies, the mungoose and the related species, are destroyed on a large scale. This in turn may have a reflection on the incidence of Plague.

Should Rabies at any time break out near a large town with a big dog population, it will be necessary to take more drastic measures. Although cases have occurred near such towns as Bloemfontein and Carnarvon, no such outbreaks have yet occurred. To be ready for such an eventuality, a rabbit virus fix strain is being prepared if it should be necessary to make vaccine for dogs.

THE PROBABLE ORIGIN OF THE DISEASE.

The origin of the disease which exists in the Union at present is somewhat obscure. The possible sources that suggest themselves are: Introduction from Europe or Asia via the seaports and from neighbouring territories via the land borders. As stated previously an outbreak of Rabies occurred at Port Elizabeth in 1893 which was traced to an Airedale terrier, imported from England, and between 1902 and 1913 Rabies was prevalent in Southern Rhodesia. Apart from these two known cases, the possibility of introduction through one of the seaports or from one of the neighbouring territories having occurred unknown to the authorities must also be considered.

TABLE 5.

Date.	Province.	District.	Farm.	Area in Morgen.	Colonies.	Single Burrows.	Gas Used in lb.
February, 1930	Tvl.	Wolmaransstad	Cyfergat	2,000	—	—	—
				500	—	—	—
				544	—	—	—
				544	—	—	—
				750	—	—	—
February, 1930	Tvl.	,,	Diepkuil	1,100	—	—	—
				?	—	—	—
				1,032	—	—	—
			Mooiplaats				
			Cyfergat				
			De Naald				
			Cyfergat	10,400	—	—	—
			Wildebeeskuil				
			Zonderhoud				
			Vrouwpan				
May, 1930	O.F.S.	Boshof	Dealesville (Townlands)	3,660	223	195	75
June, 1930	,,	,,	Aanslot	296	19	59	30
,,	,,	,,	Doorndam	1,200	194	270	125
,,	,,	,,	Doornrandjie	800	92	183	40
,,	,,	,,	Krompsruit	1,300	144	430	200
,,	,,	,,	Lelieshoek	1,000	269	691	265
July, 1930	,,	,,	Katani and Oxford	1,600	205	527	240
,,	,,	,,	Goedehoop	800	198	396	140
August, 1930	,,	,,	Blandfort	1,600	248	670	250
,,	,,	,,	Inhoek	800	158	360	115
,,	,,	,,	Brakfontein No. 307	1,200	63	218	75
,,	,,	,,	Brakfontein No. 308	1,400	110	277	150
,,	,,	,,	Karreeboom	545	78	186	75
,,	,,	,,	Mooiplaats	2,000	170	505	325

TABLE 5—(*continued*).

Date.	Province.	District.	Farm.	Area in Morgen.	Colonies.	Single Burrows.	Gas Used in lb.
September, 1930...	O.F.S.	Boshof	Martensdam	1,000	136	214	275
,,	,,	,,	Churchhill	400	36	164	75
,,	,,	,,	Brereton	1,000	75	199	100
,,	,,	,,	Blenheim	1,445	89	218	175
,,	,,	,,	Rooiwalsnek	500	49	70	75
,,	,,	,,	Kopfontein	500	86	302	165
,,	,,	,,	Buitendam	1,300	65	188	75
October, 1930	,,	,,	Wonderkop	1,365	387	1,198	500
,,	,,	,,	Varkfontein	300	46	207	75
,,	,,	,,	Rooiwal	565	123	397	150
November, 1930	,,	,,	Witdam	1,365	205	961	275
,,	,,	,,	Kalkfontein	900	129	375	125
,,	,,	,,	Witkraal	400	128	282	125
,,	,,	,,	Mooihoek	400	88	332	100
December, 1930	,,	,,	Vrederust	326	46	211	75
,,	,,	,,	Wolvepan	1,100	350	792	250
January, 1931	,,	,,	Walviskuil	1,000	327	811	225
,,	,,	,,	Constantia	1,000	130	864	100
,,	,,	,,	Brakfontein	1,000	164	426	125
,,	,,	,,	Tuin	1,300	236	593	175
,,	,,	,,	Eben	480	47	40	50
,,	,,	,,	Valdam	350	45	132	50
February, 1931	,,	Trompsburg	Keerom	650	48	127	50
,,	,,	,,	Rietfontein	2,675	137	627	125
,,	,,	,,	Eensgevonden	1,500	30	122	50
April, 1931	C.P.	Middelburg	Manorholm	8,000	699	27	250
,,	,,	,,	Culmstock	480	108	387	100
,,	,,	,,	Ridgewater	4,000	85	364	75
June, 1931	O.F.S.	Boshof	Kromdraai	1,600	504	1,502	300

Hutcheon, who was mainly responsible for the suppression of the Port Elizabeth outbreak, in one of his annual reports expressed the fear of the disease spreading to wild carnivora especially jackals. To the best of our knowledge no such cases occurred. When discussing the geographic distribution attention was drawn to the case of Rabies at Cradock in 1931 quite close to Port Elizabeth. In 1930 cases also occurred at Middelburg just to the north of Cradock. In such relatively highly developed districts it is most unlikely for the disease to have existed since 1893 without being recognized. These cases can, however, readily be explained as the result of migration from the north, when the maps are studied.

All three these cases moreover were transmitted by species of the family Viverridae and the striking epizootological feature of Rabies in South Africa is the adaption to this family. Not a single case of Rabies has ever been diagnosed in other families of wild animals in the Union. It is doubtful moreover whether this adaption can have occurred in such a short period, 1893-1930.

Could the introduction have occurred subsequently through one of the ports? We know that the one occasion when European street virus was introduced the disease flared up and a large number of dogs became affected. No such outbreak occurred nor could one have occurred without our knowledge. The geographic distribution and the adaptation to the Viverridae can also be cited against such a possibility.

The outbreak in Southern Rhodesia from 1902 to 1913 reported by Gray and Sinclair is frequently considered a possible source of the cases at present occurring in the Union. This view was expressed by Du Toit (1928) as being the most likely explanation. But the cases occurring there apart from the human cases occurred in dogs and the larger wild carnivora, in a similar form as it occurs in Northern Rhodesia, Kenya and other Central African States. That wild carnivora such as hyaenas, jackals, and so-called wild dogs, roam over large tracts, is well known. The possibility of the Rhodesian outbreak spreading to the Transvaal was guarded against by the authorities at the time, and no dogs taken to the Limpopo area, which is the Transvaal-Rhodesia border, were allowed to return. One frequently hears and reads of wild carnivora that are seen in areas where they are not known to occur any more. One such authentic case occurred recently when two hyaenas were caught in a trap by a farmer on Groenvallei near Boekenhout, north of Nylstroom. As far as is known no hyaenas have been present there for at least 20 years. Such cases of animals getting the " wanderlust " and leaving their present haunts, are known as regards other species of wild carnivora also. When this takes place with apparently normal animals, is it not far more likely to occur with rabid animals? That rabid animals entered the Transvaal from the Rhodesian border during the outbreak there in the early part of the century is possible, but there was never at any time any report of a severe outbreak nor does one hear of rumours from natives of cases from such origin. More or less vague reports of cases transmitted by Genetta are heard from natives in the Northern Transvaal Bushveld. They state that when a man is bitten by a genet cat he gets sick in from one to three weeks, goes mad, and dies.

The possibility of the Union outbreak having spread from Southern Rhodesia during the first or second decade of this country cannot be entirely contradicted but in accepting it one would have to supply reasonable explanations to the following:—

1. The adaptation of the virus to the family Viverridae.
2. The absence of cases in large wild carnivora, e.g. jackal and hyaena.
3. The absence of known recent outbreaks in the Northern Transvaal, which is the natural transport route between the Union and Southern Rhodesia, whose wild fauna trek backwards and forwards across the Limpopo River, the boundary between the territories.

The nature of the disease as it existed in Southern Rhodesia early in the present century indicates that it probably originated from Northern Rhodesia, but the same evidence makes it unlikely that the present Union outbreak came from Southern Rhodesia.

The fourth possible source mentioned, namely, importation via the land borders from the other neighbouring territories, South-West Africa and Portuguese East Africa, must be discounted owing to the complete lack of positive evidence of the existence of the disease in these countries within recent years.

The authors are of opinion that Rabies has existed in the colonies now forming the Union of South Africa for many years before the first cases mentioned in Table 1 were reported. Positive evidence supporting this view is mainly of hearsay nature. Stories of genet cats and meercats behaving strangely are frequently heard on farms, and elderly natives all fear the bite of the " Thsipa ". Fitzsimons in his " Natural History of South Africa " states that " The Saliva of this Animal (referring to the genet cat) possess some poisonous property . . ." the bite being ". . . followed later by symptoms which resemble Hydrophobia more or less " and the patient dies two to three weeks later. The disease as stated in the introductory part of this report is also mentioned in historical writings between the years 1772 and 1861; all of which points to a Rabies-like disease having existed probably for centuries without a single flare up, such as is common in other countries where Rabies is known. There seems to be a complete adaptation to one family of carnivora and occasionally a domestic animal or a human being is accidentally bitten and contracts the disease. There the outbreak ends in spite of the fact that conditions are being favourable for the spread of the disease even in country districts, where large numbers of dogs are kept and licensing and control are only nominal. The number of wild carnivora, especially jackal, is also very great. This striking epizootological feature, the adaptation of the disease to one family, is surely not something which can occur in so short a period as a decade or two.

It must be remembered, though, that this feature of the disease makes effective control almost impossible. Moreover, it has been proved that domestic animals are susceptible and at this laboratory a jackal has been infected experimentally. Any chance infection of other carnivora, therefore, may cause the disease to spread amongst these families and the virus to become adapted to them. We can only

hope that this will not happen. It is hoped, furthermore, that the measures in force against the introduction of any other strain of virus continues to be successful and the present position is not complicated by an epizootic of a violent form of Rabies. The properties of this virus as it affects our small wild carnivora is being further studied, and also a rabbit virus-fixe strain is being prepared should it become necessary to control an outbreak in dogs. The hopes on the other hand that the disease will die out, as occurred in Southern Rhodesia, are very remote owing to the peculiar epizootology.

SUMMARY.

1. The history of Rabies in the Union of South Africa is discussed.

2. The diagnosis of Rabies including two tables, in which the results of the histo-pathological as well as the biological examination is mentioned, and another table where the total number per annum is shown are given.

3. The known carriers are discussed and a table giving zoological and vernacular names is appended.

4. Maps showing the distribution.

5. The methods of control.

6. The probable origin.

7. Illustrations showing the known carriers and a case of Rabies in the ox.

ACKNOWLEDGMENTS.

The authors wish to thank Dr. A. D. Thomas and Mr. C. Jackson for carrying out the histo-pathological examination of the brain material from the original and experimental cases. Thanks are due to Mr. F. Boughton and Mr. W. Powell, Jun., for assisting in the operations and keeping records, Mr. Roberts for giving information as regards identification of the members of the family Viverridae, to Mr. W. Powell, Senior Rodent Inspector, for conducting one of the authors on a trip through the infected areas of the Western Transvaal, and to Mr. T. Meyer, for printing the photographs, and last but not least to Mr. R. Alexander for allowing us to make use of his observations.

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Fig. 1.—*Genetta felina.*

Fig. 2.—*Suricata suricatta.*
[Reproduced from *Natural History of South Africa*, Vol. II, by F. W. Fitzsimons.]

Fig. 3.—*Myonax pulverulentus.*
[Reproduced from *Natural History of South Africa,* Vol. II, by F. W. Fitzsimons.]

Fig. 4.—*Cynictis penicillata.*

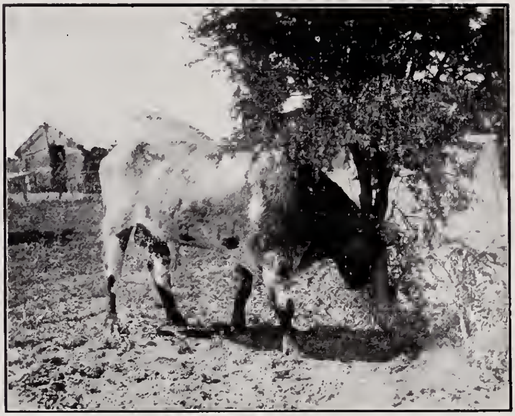
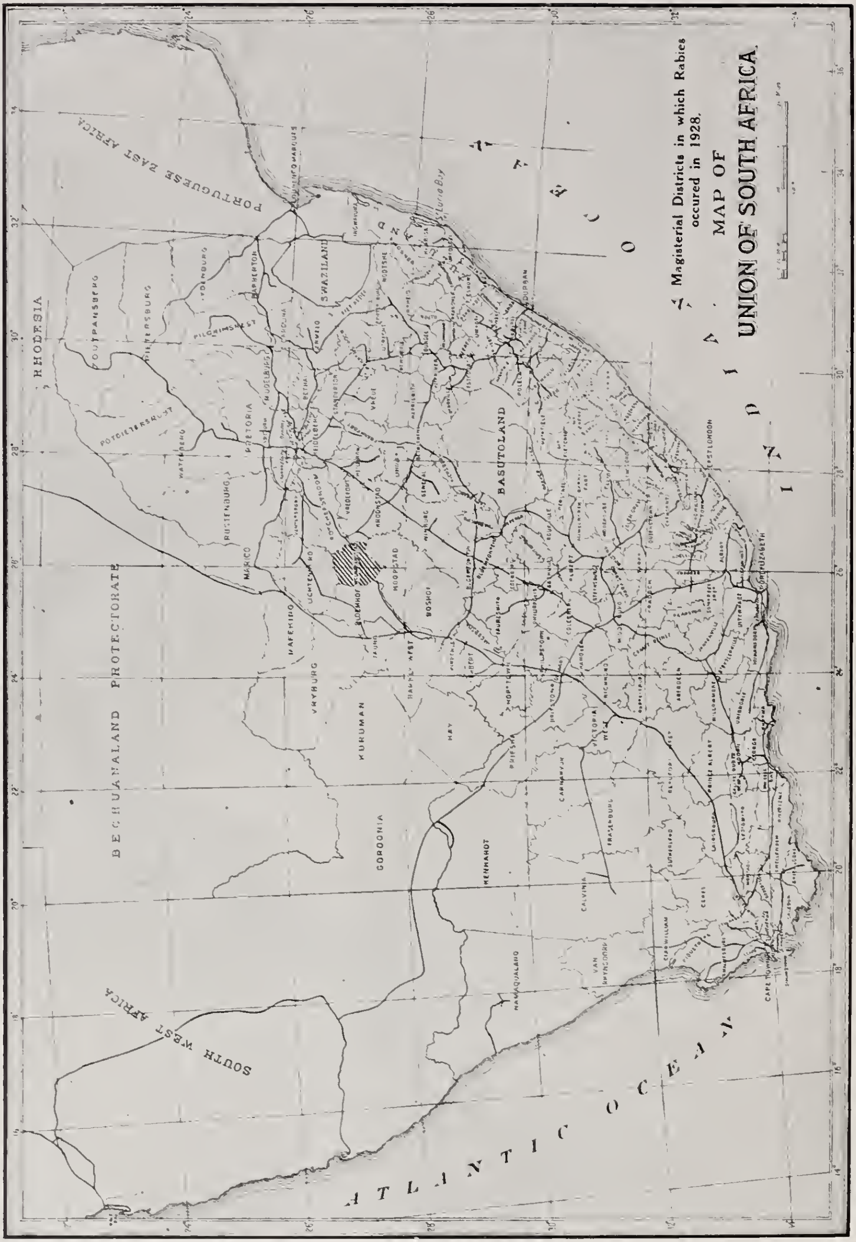
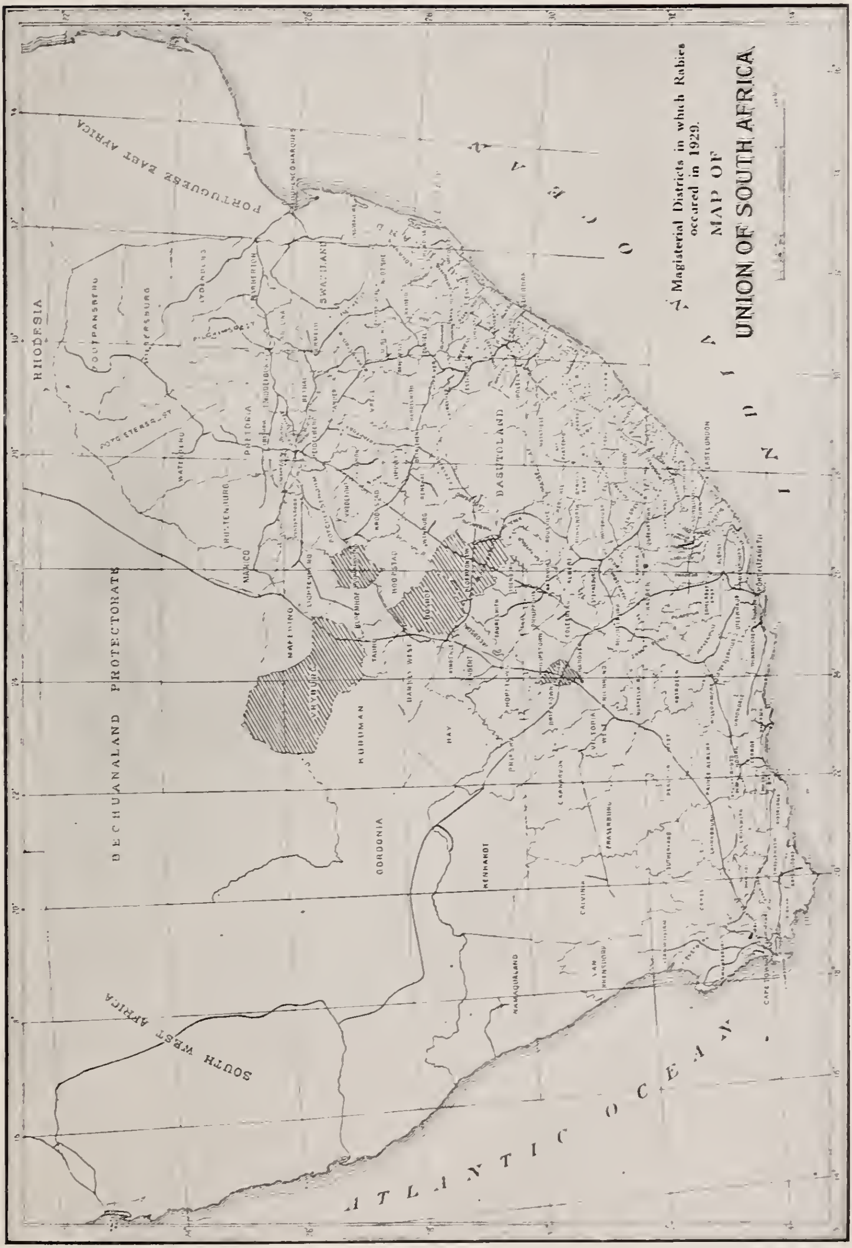


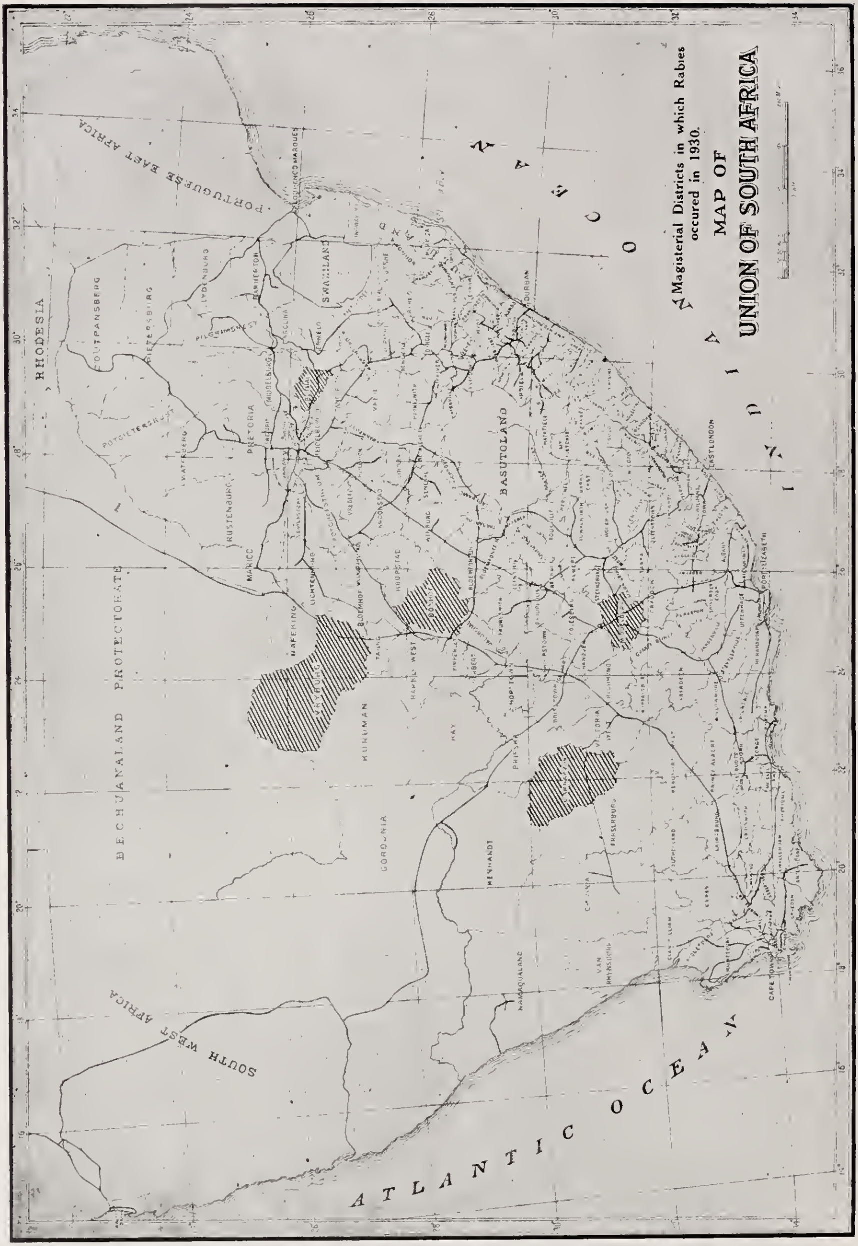
Fig. 5A.—Shorthorn bull suffering from rabies Zaaiplaats, Vryburg.
[Specimen 4765 and 4766, Case XIX, October, 1930.]
[*Photograph by Mr. J. H. Bisschop.*

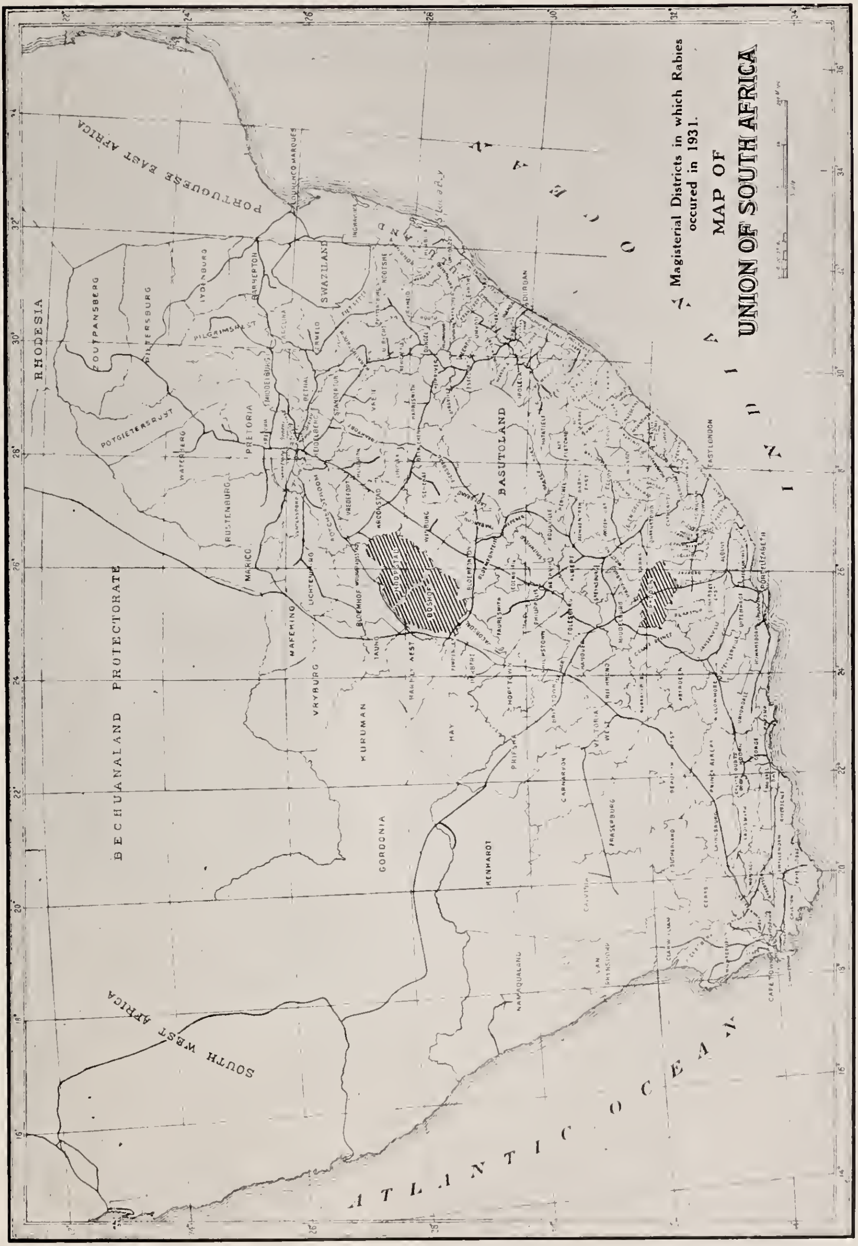
Fig. 5B.—Shorthorn bull suffering from rabies, Zaaiplaats, Vryburg.
[Specimen 4765 and 4766, Case XIX, October, 1930.]
[*Photograph by Mr. J. H. Bisschop.*

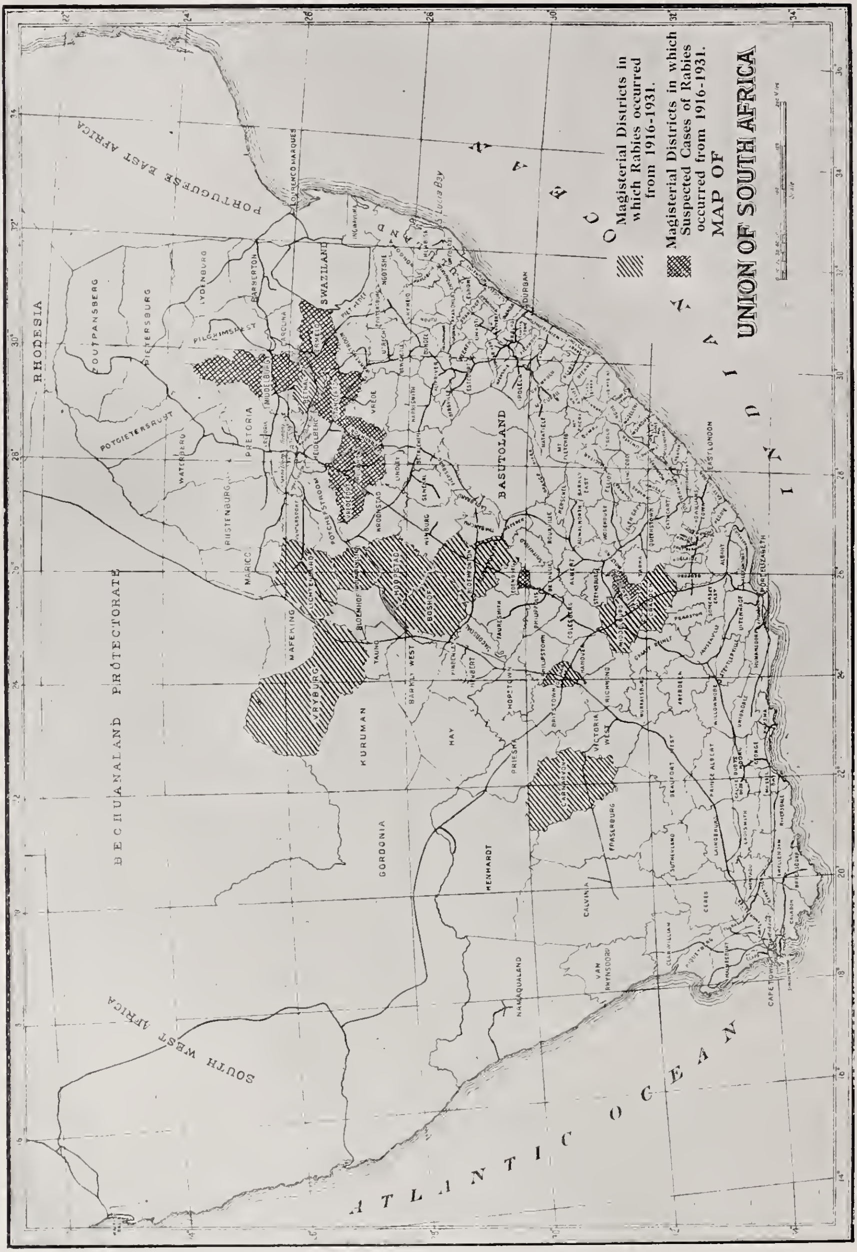

Magisterial Districts in which
Suspected Cases of Rabies
occurred from 1916-1927.
MAP OF
UNION OF SOUTH AFRICA
RHODESIA
PORTUGUESE EAST AFRICA
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
SWAZILAND
BASUTOLAND
ATLANTIC OCEAN
INDIAN OCEAN


MAP OF
UNION OF SOUTH AFRICA
Magisterial Districts in which Rabies
occured in 1928.
RHODESIA
PORTUGUESE EAST AFRICA
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
BASUTOLAND
SWAZILAND
INDIAN OCEAN
ATLANTIC OCEAN
GORDONIA
KURUMAN
VRYBURG
MAFEKING
MARICO
RUSTENBURG
WATERBERG
PRETORIA
POTGIETERSRUST
ZOUTPANSBERG
PIETERSBURG
LYDENBURG
PILGRIMSREST
BARBERTON
DURBAN
EAST LONDON
PORT ELIZABETH
CAPE TOWN
KENHARDT
NAMAQUALAND
CALVINIA
HAY
BOSHOF
HOOPSTAD
LICHTENBURG
BLOEMHOF


MAP OF
UNION OF SOUTH AFRICA
Magisterial Districts in which Rabies occured in 1929.
RHODESIA
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
PORTUGUESE EAST AFRICA
BASUTOLAND
SWAZILAND
ATLANTIC OCEAN
INDIAN OCEAN
GORDONIA
KURUMAN
VRYBURG
MAFEKING
PRETORIA
MARICO
NAMAQUALAND
KENHARDT
HAY
CARNARVON
FRASERBURG
CALVINIA
VICTORIA WEST
EAST LONDON
PORT ELIZABETH
CAPE TOWN
BOSHOF
HOOPSTAD
HOPETOWN
BARKLY WEST
ZOUTPANSBERG
PIETERSBURG
WATERBERG
RUSTENBURG


Magisterial Districts in which Rabies occured in 1930.
MAP OF
UNION OF SOUTH AFRICA
RHODESIA
PORTUGUESE EAST AFRICA
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
SWAZILAND
BASUTOLAND
INDIAN OCEAN
ATLANTIC OCEAN
DURBAN
PRETORIA
VRYBURG
MAFEKING
KURUMAN
GORDONIA
KENHARDT
NAMAQUALAND
CAPE TOWN
PORT ELIZABETH
EAST LONDON


Magisterial Districts in which Rabies occured in 1931.
MAP OF
UNION OF SOUTH AFRICA
RHODESIA
PORTUGUESE EAST AFRICA
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
SWAZILAND
BASUTOLAND


MAP OF
UNION OF SOUTH AFRICA
Magisterial Districts in which Rabies occurred from 1916-1931.
Magisterial Districts in which Suspected Cases of Rabies occurred from 1916-1931.
RHODESIA
PORTUGUESE EAST AFRICA
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
SWAZILAND
BASUTOLAND
ATLANTIC OCEAN
INDIAN OCEAN

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

East African Virus Disease in Pigs.

By D. G. STEYN, B.Sc., Dr.Med.Vet., Veterinary Research Officer, Onderstepoort.

CONTENTS.

INTRODUCTION.

Recently severe outbreaks of the above disease have occurred at Messina and Louis Trichardt. Within three weeks of the appearance of the disease at Messina all the pigs in the locality died.

In the Louis Trichardt District the virus disease appeared in the Zoutpansberg Piggeries on the farm Vondeling No. 222. The mortality was 100 per cent.

In an attempt to trace the origin of the infection, it was found that skimmed milk was obtained from the Creamery, and blood from the abattoirs at Louis Trichardt for purposes of feeding to the pigs. According to certain data it would appear that the infection most probably had been carried by the blood obtained from the abattoirs. In the course of this article it will be noticed that it was previously shown that domestic pigs, which had recovered from virus disease, acted as carriers of the virus. It is, therefore, quite possible that such carriers had been slaughtered at the abattoirs at Louis Trichardt and their blood fed to the pigs of the Zoutpansberg Piggeries.

Perhaps the skimmed milk obtained from the creamery should also be considered as a possible origin of infection. At the time of the outbreak of virus disease at Louis Trichardt the disease was raging in the district of Messina, whence large quantities of milk were sent to the creamery at the former town. It is just possible that the milk could have been contaminated with the virus.

History.

In Kenya Colony Montgomery (1921) investigated a disease termed by him East African Swine Fever which, according to its incubation period, course, symptoms, post-mortem lesions and immunity, strikingly resembles and appears to be identical with a disease (Steyn, 1928) in pigs occurring in the Koedoesrand Ward, Northern Transvaal.

Montgomery transmitted the disease from affected to susceptible animals by means of subcutaneous inoculations of the virus and by placing susceptible pigs in contact with affected ones, but failed to infect cattle, horses, dogs, sheep and rabbits. He also failed to infect pigs by feeding them with potatoes and bananas into which the virus had been inserted.

Steyn (1928) was unable to transmit the disease by means of subcutaneous inoculations of the virus into horses, cattle, sheep, goats, dogs, cats, rabbits, guinea-pigs and doves, but succeeded in infecting susceptible pigs (*a*) by means of subcutaneous inoculations of the blood and bile collected form affected animals; (*b*) by placing available pigs in contact with affected pigs; and (*c*) by mixing the faeces and urine collected from affected animals in the food of susceptible pigs.

In addition it was proved that the native boy attending to the pigs carried the infection from one sty to another in spite of all the precautions that were taken, for example, using rubber boots and disinfecting these whenever a sty was entered and left.

Montgomery furthermore found the following:—

(*a*) That the virus was still alive after blood, which had been collected in oxalate carbol-glycerine, had been stored for 536 days;

(*b*) that the virus still produced the disease after the blood had been allowed to decompose for sixteen days;

(*c*) that sties, which had been left untouched for three days after the death of pigs from virus disease, still harboured the virus, but that suspectible pigs placed in sties five and a half days after the dead pigs had been removed did not contract virus disease;

(*d*) that virus disease could not be transmitted by collecting lice and fleas from affected pigs and placing these on susceptible animals.

In regard to the susceptibility of warthogs and bushpigs Montgomery writes: " As was mentioned when discussing the animals susceptible to East African Swine Fever, the Uganda bushpig and the warthog do not react to inoculation as do domestic pigs; they manifest no symptoms and are presumably immune. It would appear, however, that the immunity is not so complete as it is in oxen and sheep, and that the virus can live in the blood of wild pigs for a certain time."

Montgomery (1921) attempted to immunize domestic pigs against virus disease by means of (*a*) virus only, (*b*) antiserum (prepared in domestic and wild pigs), (*c*) immunizing them against European Swine Fever, (*d*) mixing virus with normal sera of domestic animals, and (*e*) virus modified by heating. His results were very unsatisfactory.

Walker (1930), who investigated the possibility of immunizing domestic pigs against virus disease, says "the serum simultaneous method or serum alone and contact method has proved to be the more practical and safer method of conferring an active immunity and/or combating outbreaks."

EXPERIMENTS CONDUCTED AT ONDERSTEPOORT.

A. To Ascertain the Viability of the Virus in Decomposed Blood.

Pig 726, which was suffering from virus disease, was killed *in extremis* on 24.6.31. Its heart blood was collected in citrate solution in such a way as to allow infection and then kept in an ice-chest until 2/9/31. On this date the blood was extremely decomposed.

Pig 729 was injected subcutaneously with 3 c.c. of the above filtered blood on 2.9.31. No reaction occurred.

Warthog blood, which contained the virus of East African virus disease, was stored in an ice-chest from 10.6.31 to 2.9.31 and on the latter date was in a state of extreme decomposition.

Pig 732 received subcutaneously 3 c.c. of the filtered blood on 2.9.31. No reaction occurred.

Result.—The virus of East African virus disease contained in blood, which had been stored for periods of seventy and eighty-four days respectively, and which had been allowed to decompose during this period, lost its pathogenicity.

(B) To Ascertain the Viability of the Virus in Blood stored in Ice-chests.

The virus was stored in ice-chests in the form of blood collected from positive cases of virus disease under aseptic conditions in a glycerine-oxalate mixture.

Pigs 616, 615 and 669 were injected subcutaneonsly with 1 c.c., 2 c.c. and 3 c.c. of blood which had been kept in an ice-chest for two, three and twelve months respectively.

In all cases a temperature reaction set in within thirty-six to forty-eight hours of injection, the pigs dying from virus disease on the sixth, tenth and sixth days of the experiment respectively.

Result.—The virus contained in blood collected under aseptic conditions in glycerine-oxalate is still viable after a year's storage in an ice-chest.

(C) To Ascertain the Longevity of the Virus in Sties in which Pigs have Died from Virus Disease.

Pig 676, which was injected subcutaneously with 1 c.c. of blood containing virus, died on the seventh day after inoculation.

The dead animal was immediately removed, the sty cleaned out but not disinfected and susceptible pig 671 placed in it. For the purpose of this experiment a sty with an ordinary ground floor was erected so as to create conditions simulating as closely as possible those prevailing on most of the farms.

This animal showed a temperature of 105·2° F. and 104·9° F. on the fourth and thirteenth day, respectively, after having been placed in the sty. On the twenty-fifth day another rise in temperature occurred and prevailed until death from virus disease on the thirtieth day of the experiment.

Pig 675 was placed in the same sty five days after removal of the carcase of pig 676.

In the course of the following two months no reaction ensued.

Result.—A pig which was placed in a sty immediately after the carcase of the pig, which had died from virus disease, was removed, contracted virus disease, whereas the pig, which was placed in the sty after a period of five days had elapsed from the time of removal of the carcase, did not develop virus disease.

(B) Immunization Experiments.

(*a*) With culture-sterile bile collected from pigs that died from virus disease.

Table 1.

9.11.27.

Pig No.	Date of Subcutaneous Inoculation.	Quantity and Origin of Bile Inoculated.	Result.
665	9.11.27	0·75 c.c. (pig 652)	Temperature reaction within 48 hours and death following on the 6th day after injection.
673	18.11.27	0·25 c.c. (pig 652)	Temperature reaction from 6th to 15th day after injection. No resistance to the virus disease was noticeable when this animal was injected subcutaneously with 0·25 c.c. virulent blood on the 5th day after recovery from the attack caused by the bile injection.
667	7.3.28	0·25 c.c. (pig 629)	No reaction followed.
	22.3.28	1·0 c.c. (pig 629)	No reaction followed.
	17.4.28	0·5 c.c. (pig 669)	Temperature reaction followed within 72 hours and death on the 6th day after injection.
668	7.3.28	0·5 c.c. (pig 629)	No reaction followed.
	22.3.28	3·0 c.c. (pig 629)	No reaction followed.
	17.3.28	0·5 c.c. (pig 669)	Temperature reaction within 24 hours and death within 4 days after injection.
678	16.5.28	0·125 c.c. (pig 669)	No reaction followed.
	20.6.28	2·0 c.c. (pig 669)	Temperature reaction followed within 72 hours and death within 9 days after injection.
679	16.5.28	0·25 c.c. (pig 669)	No reaction followed.
	20.6.28	4·0 c.c. (pig 669)	Temperature reaction commenced within 72 hours and death occurred within 9 days after injection.

Result.—From the above table it would appear that no success as far as immunization is concerned was obtained from the bile inoculation method.

The bile collected from pig 669 appeared to be much more virulent than that collected from pigs 652 and 629.

(*b*) With hyperimmune serum and with virus treated with disinfectants.

Table 2.

Immunization Experiments.

Pig No.	Method of Immunization.	Result.
631	0·5 c.c. virus (pig 612) mixed with 1 c.c. of a 5 per cent. Yatren puriss. No. 105 and left standing for ½ hour before injection	Died from virus disease on the 6th day after injection.
648	0·125 c.c. virus (pig 638) mixed with 2 c.c. of a 5 per cent. Yatren puriss. No. 105 and left standing for one hour before injection	Died from virus disease on the 8th day after injection.
632	0·5 c.c. virus (pig 612) mixed with 1 c.c. of a 0·1 per cent. formaldehyde and left standing for ½ hour before injection	Died from virus disease on the 9th day after injection.
646	0·125 c.c. virus (pig 638) mixed with 0·25 c.c. of a 0·1 per cent. formaldehyde and left standing for 1 hour before injection	Died from virus disease on the 6th day after injection.
647	0·125 c.c. virus (pig 638) mixed with 0·25 of a 0·4 per cent. formaldehyde and left standing for 1 hour before injection	Died from virus disease on the 6th day after injection.
663	0·1 c.c. virus (pig 638) mixed with 0·5 c.c. of a 0·4 per cent. formaldehyde and left standing for 1 hour before injection	Died from virus disease on the 12th day after injection.
617	0·1 c.c. virus (pig 638) mixed with 0·5 c.c. of a 0·8 per cent. formaldehyde and left standing for 1 hour before injection	Died from virus disease on the 21st day after injection.
636	0·1 c.c. virus (pig 638) mixed with 1 c.c. of a 0·4 per cent. formaldehyde and left standing for 1 hour before injection	Died from virus disease on the 17th day after injection.
651	0·1 c.c. virus (pig 638) mixed with 0·5 c.c. of a 1 per cent. formaldehyde and left standing for 1 hour before injection	On the 18th day after injection this pig showed a temperature of 106° F., otherwise the temperature ran its normal course up to the 28th day after injection when high fever set in. Death followed on the 35th day after injection.
639	10 c.c. hyperimmune serum (pig 604) and 0·25 c.c. virus (pig 638) subcutaneously	Died from virus disease on the 6th day after injection.
640	50 c.c. hyperimmune serum (pig 604) and 0·25 c.c. virus (pig 638) subcutaneously	Died from virus disease on the 12th day after injection.
649	50 c.c. hyperimmune serum (pig 604) and 0·125 c.c. virus (pig 638) subcutaneously	Died from virus disease on the 4th day after injection.
650	100 c.c. hyperimmune serum (pig 604) and 0·25 c.c. virus (pig 638) subcutaneously	Died from virus disease on the 7th day after injection.
662	100 c.c. hyperimmune serum (pig 606) and 0·125 c.c. virus (pig 638) subcutaneously	Died from virus disease on the 6th day after injection.
660	10 c.c. hyperimmune serum (pig 604) mixed with 0·05 c.c. virus (pig 638) before injection	Died from virus disease on the 4th day after injection.
661	25 c.c. hyperimmune serum (pig 604) mixed with 0·1 c.c. virus (pig 638) before injection	Died from virus disease on the 5th day after injection.
664	50 c.c. hyperimmune serum (pig 604) mixed with 0·1 c.c. virus (pig 638) before injection	Died from virus disease on the 5th day after injection.

Result.—From the above table it would appear—

(*a*) that a 5 per cent. Yatren solution has no influence on the virulency of the virus;

(*b*) that formaldehyde in the solutions used in the above experiment causes an increase in the period of incubation of virus disease and that the more concentrated the formaldehyde solution the longer the incubation period;

(*c*) that hyperimmune serum when injected subcutaneously in quantities up to 100 c.c. has no effect on the course of virus disease;

(*d*) that hyperimmune serum when mixed with the virus before injection does not influence the course of virus disease.

(E) To Determine whether Warthogs (Vlakvarke) act as Carriers of Virus Disease in Pigs.

Table 3.

Experiments with Warthog Blood.

Pig No.	Origin of Warthog Blood.	Result.
724	5 c.c. of citrated blood from warthog No 1 shot on the farm Berg-en-Dal, Potgietersrust	A striking temperature reaction commenced on the 6th day and continued until the 30th day after injection. Typical symptoms of virus disease were exhibited, and complete recovery occurred.
725	,, ,, ,,	A striking temperature reaction set in on the 6th day and continued until the 20th day after injection. During the course of the temperature reaction the animal showed typical sumptoms of virus disease. Recovery occurred.
726	5 c.c. of citrated blood from a warthog shot on the farm Gruispan, Potgietersrust	A temperature reaction and typical symptoms of virus disease set in on the 5th day after injection. This animal was shot in *extremis* on the 13th day after injection.
727	5 c.c. of citrated blood from a warthog shot on the farm Welgemoed, Potgietersrust	A temperature reaction set in on the 10th day after injection. After the animal exhibited a train of typical symptoms of virus disease, it died on the 20th day after injection.
738	5 c.c. of citrated blood from a warthog shot on the farm Oranjefontein, P.O. Koedoesrand, Potgietersrust	No reaction followed.
737	5 c.c. of citrated blood from two warthogs shot in the Umfolozi Game Reserve, Natal	No reaction followed.
733	5 c.c. of citrated blood from two warthogs shot in the Umfolozi Game Reserve, Natal	No reaction followed.

Result.—Pigs 724 and 725 were injected subcutaneously with blood from the same warthog, both animals recovering after a severe attack of virus disease. These two pigs will again be referred to in experiment (F).

Pig 731 was inoculated subcutaneously with blood from pig 726 with the result that it developed typical symptoms of virus disease and died within six days of injection. The incubation period was thirty-six hours.

Furthermore, as soon as it was noticed that pig 727 was ill, pig 730 was placed in contact with it. The latter pig developed a temperature reaction on the sixth day and died from virus disease on the sixteenth day after it had been placed in contact with pig 727.

From the above table it is evident that three out of four apparently healthy warthogs shot in the Koedoesrand Ward, Potgietersrust District, were found to be carriers of the virus of virus disease in pigs, whereas the blood of six apparently healthy warthogs shot in the Umfolozi Game Reserve, did not harbour the virus.

(F) To Determine whether Domestic Pigs that have Recovered from Virus Disease act as Carriers of the Virus.

For this purpose blood was collected from pigs 724 and 725 [see experiment (E) Table 3], two months after complete recovery from virus disease had occurred and injected subcutaneously into pigs 739 and 740 respectively.

Result.—Pig 739 developed a temperature reaction within thirty-six hours after injection and died within twelve days of injection having exhibited typical symptoms of virus disease.

Pig 740 died on the eleventh day after injection having shown typical symptoms of virus disease from the fourth day after injection.

DISCUSSION.

Viability of the Virus in Decomposed Blood.

The process of decomposition when allowed to continue for a certain period destroys the virus contained in blood. Montgomery was able to produce virus disease in a pig by injecting it with blood which had been collected from a case of virus disease and which had been allowed to decompose for sixteen days. The author was unable to produce virus disease in pigs by injecting them with blood which had been collected from cases of virus disease and which had been allowed to decompose in an ice-chest for periods of seventy and eighty-four days respectively.

I might mention that blood collected from decomposed carcases and allowed to decompose for a further period of five days was still capable of producing virus disease in susceptible pigs.

The Viability of the Virus in Culture Sterile Blood Stored in Ice-chests.

Montgomery established that the virus contained in preserved blood was still viable after storage for a period of five hundred and thirty-six days.

At Onderstepoort the virus contained in culture sterile blood collected in glycerine-oxalate was still viable after a year's storage in an ice-chest.

The Longevity of the Virus in Sties.

At Onderstepoort a pig that was placed in a sty immediately after the removal of the carcase of a pig that had died from virus disease contracted the disease and died, whereas a pig that had been placed in the same sty five days after removal of the second dead pig remained healthy. In this respect the following case that occurred in the Louis Trichardt District might be of interest.

In a private letter Mr. Lawrence, who is one of the owners of the Zoutpansberg Piggeries at Louis Trichardt, mentioned that he had placed pigs in virus disease infected sties three weeks after the removal of the infected animals and in spite of the fact that these sties had been repeatedly disinfected with strong Kerol at intervals of a few days, virus disease again broke out among the newly introduced pigs.

The viability of the virus in infected sties will naturally depend on the weather conditions, the type of sty (whether ground or cement floor, etc.), and the method and thoroughness of disinfection.

Immunization against Virus Disease.

At Onderstepoort no promising results were obtained with bile, yatren + virus, formaldehyde + virus, simultaneous injections of hyperimmune serum, and virus, and by mixing the virus with hyperimmune serum in an attempt to produce immunity to virus disease in pigs. Montgomery failed to produce immunity against virus disease by means of *(a)* virus only, *(b)* antiserum prepared from domestic and wild pigs, *(c)* immunizing pigs against European swine fever, *(d)* mixing virus with normal sera of domestic animals, and *(e)* virus modified by heating.

It will be noticed that both Montgomery and the author had no success in immunizing domestic pigs against virus disease by means of virus and antiserum, while Walker found it the most reliable method of immunization.

It is possible that the virulency of the virus used in the production of antisera plays a rôle in determining the value of such antisera, although it must be added that the virus utilized in the production of hyperimmune serum at Onderstepoort was of the most virulent type.

Warthogs (Vlakvarke) as Carriers of the Virus of Virus Disease in Pigs.

It was definitely proved that warthogs running in areas where virus disease in pigs occurs may act as carriers of the virus, whereas the presence of such a virus could not be demonstrated in the blood of warthogs in a virus disease free area (Umfolozi Game Reserve, Zululand).

Domestic Pigs, which have Recovered from Virus Disease, as Carriers of the Virus.

Two domestic pigs, which had contracted virus disease from subcutaneous injections with blood from a warthog which had been shot in the Koedoesrand Ward, recovered after severe attacks of the disease. These two pigs were found to harbour the virus in their blood two months after complete recovery from virus disease had occurred.

From the results of this and the previous experiment, it would appear that the virus harboured by warthogs becomes more virulent when passed through domestic pigs.

Montgomery injected bush pigs and warthogs with the virus and found that they developed no symptoms or only a slight temperature reaction and that they harbour the virus for a certain time.

That warthogs harbour the virus of virus disease would explain unsolved outbreaks of this disease in pigs in localities where the channel of introduction of the infection has been unknown.

It was proved (Steyn, 1928) that the faeces and urine of domestic pigs suffering from virus disease contain the virus. In view of this fact it would appear quite possible that warthogs harbouring the virus might infect domestic pigs by means of their droppings in farm yards while scavenging for food.

It is common knowledge amongst farmers in bush-pig and warthog areas that these wild pigs frequently find their way into the pig sties and take food from the troughs, and also that bush pigs cohabitate with domestic pigs.

As was remarked in the introduction to this article the mysterious outbreak of virus disease in the Zoutpansberg Piggeries at Louis Trichardt may have been, and most prbably was, due to a " carrier " having been slaughtered at the Louis Trichardt abattoirs and its blood fed to the pigs at the Zoutpansberg Piggeries.

The fact that pigs which have recovered from an attack of virus disease harbour the virus precludes the use of a vaccine which contains the live virus, as the immunization of pigs by this means will create " carriers ".

In the light of our present knowledge the only way of combating virus disease in pigs is to slaughter all the affected and in-contact animals and to quarantine affected localities.

CONCLUSIONS.

1. The virus of virus disease is destroyed by allowing citrated blood from affected animals to decompose for periods of seventy and eighty-four days. On the other hand, blood which was in a state of complete decomposition five days after collection still harboured the virus.

2. Blood when mixed with preservative and stored in an ice-chest harbours the virus for considerable periods.

3. It has been found that under natural conditions sties in spite of repeated disinfection with Kerol are still infectious three weeks after removal of dead and affected pigs.

4. In the immunization experiments no promising results were obtained from the following: (*a*) bile method; (*b*) Yatren + virus method; (*c*) formaldehyde + virus method; (*d*) simultaneous injections of hyperimmune serum and virus; and (*e*) by mixing the virus with hyperimmune serum before injection.

(5) Some warthogs, although in good health, in certain parts of the area in which the virus disease in pigs occurs, harbour the virus in their blood.

6. It was established that domestic pigs still harbour the virus in their blood two months after they had recovered from an attack of virus disease.

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Immunisation of Fowls against Fowl Pox by use of Pigeon Pox Virus.

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INTRODUCTION.

Fowl pox is a disease that is widespread throughout the Union and, as a result of it, big losses are suffered by the poultry farmer annually. This is especially the case from about August to December. Varying methods have been tried in an attempt to obtain a vaccine that is effective yet safe. Some have yielded promising results, only to break down when subjected to severe tests. So far pigeon pox vaccine appears to hold out the best hopes for success.

BRIEF SURVEY OF WORK CARRIED OUT BY PREVIOUS INVESTIGATORS.

The introduction of the method of preventative vaccination was brought to notice by Beach (1920) and also in a paper read at the First World's Poultry Congress, held at the Hague in 1921. At about the same time De Blieck and Van Heelsbergen, of Utrecht, had been working in the same direction.

Boener and Stubbs (1922) and Ward and Gallagher (1922) working with the vaccine prepared by Beach did not have good results. This vaccine consisted of a 1 per cent. saline suspension of finely powdered crusts heated for 1 hour at 55° C.

De Blieck (1927) did not report favourably on this vaccine and claimed that his vaccine Antidiphtherin yielded better results. It is thought, however, that this vaccine is prepared from pigeon pox material.

Doyle and Minett (1927) showed that pigeon pox virus protected fowls against natural fowl pox.

Zwick, Seifried and Schaaf (1928) recorded the successful employment of pigeon pox virus for the protection of fowls against fowl pox and claimed an absolute immunity to natural infection with fowl pox virus.

Lahaye (1928) made similar claims and also stated that the immunity lasted for more than a year.

Doyle (1930) published results of work done on the use of pigeon pox vaccine in conferring immunity against fowl pox but stated it was not a complete protection against severe artificial infection but gave a solid immunity against natural infection with fowl pox.

Zwick (1931) gives a review of different methods of treating the virus with the results obtained from their use. In his article many workers have been named. His conclusions were that antidiphtherin (probably pigeon virus alone or pigeon and fowl virus mixed), fowl pox virus modified by passage through pigeons, pigeon pox virus and mixed virus all offer promising methods of conferring immunity on fowls against fowl pox. He gives methods for the preventative vaccination and for vaccination where the disease has already broken out.

Johnson, E. P. (1931) stated good results had been obtained in America with pigeon pox vaccine and claimed that it did not affect the egg production.

Beach (1931) refers to the different methods of preparation of fowl pox vaccine and methods of vaccination such as the " follicle " and the " stick " ones. Throughout his article he makes no mention of immunity obtained by use of pigeon pox virus. He gives a list of workers on fowl pox in the United States of America. Apparently he believes more in the use of fowl pox vaccine than in the pigeon pox one.

OBJECTS OF EXPERIMENTS.

The objects of these experiments were twofold: (*a*) to prepare a vaccine that would protect fowls against fowl pox and (*b*) to do away with all risk of setting up an attack of fowl pox in healthy fowls as a result of the vaccination. Farmers who have used the vaccine prepared from fowls have in many cases claimed good results from it but occasionally a new batch of vaccine—although prepared in the usual manner—when used gives few, very slight or no reactions, or even starts a mild outbreak of fowl pox. These outbreaks are usually attributed to the vaccine. A more likely explanation is that the disease is already present among the fowls. The bad hygienic conditions under which the fowls are kept further reduce the vitality of the birds. On numbers of occasions a batch of vaccine which has been blamed for killing birds has been tested out on young susceptible fowls kept under good hygienic conditions and only a marked reaction has been observed. It is admitted, however, that such a vaccine may cause an outbreak among fowls kept under dirty conditions. It is also claimed by farmers that frequently when young pullets that are just beginning to lay are vaccinated and a good reaction results, these birds are not only put off the lay but sent into a moult. Often a natural outbreak of fowl pox takes place at about 2 to 4 weeks of age with resultant heavy losses. If a farmer wishes to prevent such an outbreak and vaccinates his young birds at this age it is highly probable that he will lose as many chickens as a result of the vaccination as he would from the natural outbreak. This is one reason why vaccination is advised at 6 weeks of age at the earliest.

Further, the method of vaccination with fowl pox vaccine is not quite as simple and fool proof as one might imagine from reading the instructions. Frequently a batch of vaccine which on being tested out prior to issue has given good reactions, gives no reactions or only very slight ones in the poultryman's hands. This can often be traced to the fact that his scarification has been very superficial or that he has disinfected the site too well before scarification, or finally, that he has neglected to shake the bottle well before use.

Another point that the poultryman does not bear in mind is that among a flock of young birds a certain number have a natural immunity to the disease and no matter how well the operation has been carried out and how strong the vaccine, little or no reaction will take place. Complaints are the result.

From the laboratory point of view there are a number of difficulties to be overcome in the preparation of fowl pox vaccine. One has to obtain young cockerels of from 3-4 months of age and these birds must have well developed combs on which to grow the fowl pox material. As incubation usually only takes place during certain

months of the year, one's opportunity for preparation is strictly limited to this period. If by chance a supply of virus material runs short and one wants to prepare more in a hurry, it is usually most difficult if not impossible to obtain suitable birds. One's difficulties do not end there. Such birds must be susceptible and must never have been in contact with fowl pox or have had the disease. Owing to the widespread distribution of this disease, few farms may be called clean so our choice is again confined to these few clean farms. When the fowl pox virus is ready for removal the birds have to be dubbed, i.e. the combs removed by operation in order to prevent large amounts of blood being mixed with the virus.

Many of these difficulties are overcome by use of pigeon pox vaccine. An outbreak of fowl pox is not set up by the use of pigeon pox vaccine. This does away with the possibility of starting an outbreak of fowl pox. Chickens, a few days old, can be vaccinated with safety. The actual vaccination process is much simplified and it is not necessary to obtain any special virus producers. The virus can be prepared at any time of the year and from any pigeon.

PROBLEMS TO BE INVESTIGATED.

(*a*) Infectivity of Fowl Pox and Pigeon Pox Virus.

It was claimed by many workers—Jowett, Carnwath, Basset—[cited by Doyle and Minett (1927)] that is was most difficult to infect pigeons with fowl pox virus. Doyle and Minett (1927) frequently attempted to infect pigeons with fowl pox virus by the cutaneous, subcutaneous and intravenous methods, but negative results were the outcome. By special methods they were eventually able to grow it well after about the fifth passage. Zwick, Seifried and Schaaf (1930) tried alternate transmission of fowl pox virus to the rabbit and hen, but did not obtain an adaptation of the virus. Its use, however, conferred a degree of immunity. They again tried protracted passages on a rabbit and reduced its virulence thereby, but use of this modified virus also conveyed a degree of immunity. Zwick (1930) quotes Bierbaum, Eberbeck and Rasch as using a mixed virus of hen and pigeon pox types which they further cultivated on pigeons. They would not state definitely whether the good effects were due to the pigeon pox virus or the fowl pox one or to the mixture of the two. Judging from previous results obtained by other workers and our own experience, the evidence tends to favour the pigeon pox. One would almost go as far as to say that their virus was a pure pigeon pox one. He also quotes Saito, who claims that fowl pox virus does not undergo any considerable modifications in pigeons but gradually adapts itself to the pigeon by passage through this bird and on reinoculation from the pigeon to the fowl the virus has become considerably attenuated. He comes to the conclusion that the most promising results are to be expected from the use of actual pigeon pox virus, or fowl pox virus passed in various ways through pigeons.

Morcos (1931) states that pigeons vaccinated with fowl pox virus by scarification developed lesions within 12 days.

It was here found that when the combs of cockerels were scarified and pigeon pox virus rubbed in, the first bird used gave only very slight growths, but on preparing a vaccine from this and continuing by passage through fowls it became quite profuse after about the fifth passage.

Another strain available here was obtained from a natural case in an Australian ring dove. A vaccine was obtained by crushing up scabs in glycerine. It was passed through two fowls on their combs, good growths resulting. The material was kept sealed up in tubes for 18 months. A concentrated vaccine in pure glycerine was then made up, using only enough glycerine to bind the ground up scabs together. The pigeon was scarified on the breast and the vaccine rubbed well in. This was continued through seven generations. The results are shown below:—

Passage.	Strength of Vaccine.	Vehicle for Vaccine.	Method of Vaccination.	Results.
1	Concentrated	Pure glycerine.	Scarification of breast	Very slight growth.
2	,,	,, ,,	,, ,,	,, ,, ,,
3	,,	Pure liquid paraffin	,, ,,	Slight growth.
4	2 per cent...	,, ,,	Rubbed over plucked breast	,, ,,
5	,,	,, ,,	,, ,,	Good growth.
6	Concentrated	,, ,,	,, ,,	,, ,,
7	,,	80 per cent. glycerine in ·85 per cent. saline	,, ,,	Profuse growth.

Conclusion.—It would appear that the modified dove virus when passed through fowls and then brought on to pigeons, only grows well after repeated passage.

A further interesting fact was noted. A pigeon on which the first passage was carried out, was liberated on 11.8.31, a week after vaccination. On 4.9.31 a typical pigeon pox nodule was observed over the right eye. Lesions eventually developed round both eyes and under the throat. Some lesions were still present on 6.10.31, but the bird was lively and ate well, and to-day has quite recovered. From the time of its liberation it was in direct contact with artificially produced cases of true pigeon pox, so it is surmised that it became infected from these birds.

Conclusion.—It would appear that this dove virus, passed through fowls, did not convey to the pigeon under consideration, any degree of immunity to pigeon pox.

Again, a bird used in the sixth passage, while still in a cage and 22 days after vaccination, developed several typical pigeon pox nodules round both eyes. These soon cleared up.

(*b*) Preparation of Vaccine.

To obtain a strain of pigeon pox in South Africa was impossible. Requests were made to numerous homing club secretaries and private pigeon fanciers, but they had never seen the condition. They mentioned a disease they called canker that affected the mouth and throat but stated this never gave rise to typical nodules round eyes or nose. This condition will be investigated later. Through the courtesy of Dr. E. Robinson, of Onderstepoort, a strain of pigeon pox known as the Rossi strain was obtained. This virus came from the Department of Animal Pathology, Cambridge University. All the vaccine prepared for this work has been obtained from the use of this strain I have since obtained a strain of pigeon pox from Egypt sent over by Professor Morcos of the Cairo School of Veterinary Medicine.

This Rossi strain had been removed from a pigeon on 4.10.30, so at the time of using it it was 10 months old. Not having had any previous experience of this virus and fearing it might be too old I adopted a different method for obtaining a growth. Instead of plucking the feathers from the breast and rubbing on a definite strength of virus—the method of de Blieck and van Heelsbergen—it was decided to pluck the breast, then scarify and finally rub on the material.

Experiment 429.—To propagate the Rossi strain on susceptible healthy pigeons.

Date.	Remarks.
4.8.31	Pigeon 1 vaccinated with concentrated solution of ground up dried scabs. Breast plucked and scarified. Vehicle of solution pure glycerine.
6.8.31	Slight oedema of breast muscle.
8.8.31	Thin yellowish areas along lines of scarification.
11.8.31	Thin yellowish crusts collected and feathers regrowing over scarified area removed.
12.8.31	Follicles enlarged on vaccinated areas.
13.8.31	Secondary scabby growths commencing.
20.8.31	Marked secondary growth, thick yellowish brown crusts present, material collected.
3.9.31	Diphtheritic material formed inside mouth and on tongue, mouth held partly open.
5.9.31	Quantity of blood from mouth, bird visibly ill.
24.9.31	Top beak sloughed off.
30.9.31	Lower beak sloughed off.

Results.—Good growth of virus material obtained.

Conclusions.—Virus material 10 months old imported from England was still strongly virulent; in fact, virulent enough to set up the actual disease. This may have also been due to scarification in addition to pulling out of feathers of breast.

Experiment 491*a*.—To propagate second generation of Rossi strain on suspectible pigeons.

Date.	Remarks.
11.8.31	Pigeon 2 vaccinated with freshly removed scabs from Pigeon 1. Scabs mashed up in pure glycerine. Breast plucked and scarified and vaccine rubbed in.
13.8.31	Thin brownish yellow crusts forming along breast.
16.8.31	Large brownish yellow crust formed on front of breast, several small yellowish crusts forming along sides of breast, follicles swollen.
20.8.31	Crusts coalesced over whole breast.
28.8.31	Crusts drying up, raised above surface of breast.
31.8.31	Material collected.

Results.—Good growth of virus material obtained.

Experiment 429*b*.—To propagate third generation of Rossi strain on suspectible pigeons.

Date.	Remarks.
20.8.31	Pigeon 3 vaccinated with freshly removed scabs from Pigeon 2. Scabs mashed up in pure glycerine. Breast plucked and sacrified and vaccine rubbed in.
26.8.31	Good commencing reaction, oedema of breast.
28.8.31	Follicles markedly swollen.
31.8.31	Commencing scab formation over whole breast.
3.9.31	Crusts well formed, yellowish brown.
4.9.31	Lesions of pigeon pox on lid of right eye, few small diphtheritic patches on mouth.
6.9.31	Crusts drying—lesions very marked.
12.9.31	Crusts removed.
14.9.31	Bird destroyed and lesions photographed.

Results.—Good growth of virus material obtained.

Conclusions.—It appeared as if the strain was becoming too virulent and scarification caused too marked a reaction.

Experiment 429*c*.—To propagate fourth generation of Rossi strain on susceptible pigeons. Birds not to be scarified.

Date.	Remarks.
14.9.31	Pigeon 4 vaccinated with 50 per cent. strength vaccine prepared from freshly removed scabs of pigeon 3. Breasts plucked and virus rubbed on. Vehicle of solution—Liquid paraffin.
19.9.31	Follicles becoming enlarged, small amount of yellowish dried exudate on surface of many follicles.
23.9.31	Crusts fusing over groups of follicles.
28.9.31	Scab formation covering breast, marked yellowish brown.
30.9.31	Diphtheritic patches in mouth and on tongue.
2.10.31	Crusts removed.
3.10.31	Pigeon died.

Results.—Good growth of pigeon pox virus material obtained.

Conclusion.—The methods adopted did not have any effect in reducing the virulence of the virus. These methods were (*a*) the use of a weaker strength of vaccine, (*b*) no scarification, and (*c*) a new vehicle for making up vaccine.

Experiment 429*d*.—To propagate the fifth generation of the Rossi strain on susceptible pigeons.

In this experiment, which was similar to 429*c*, three pigeons were used and all were vaccinated as with the fourth generation preparation.

Results.—Similar to 429*c*. Two of the birds died.

Conclusions.—The virulence of the strain was now too strong. Methods of attenuating should be tried.

Experiment 429*e*.—To propagate the Rossi strain on susceptible pigeons, making attempts to secure a good growth without killing the birds.

Date.	Remarks.
13.11.31	Two pigeons vaccinated with 10 per cent. virus, one month old, made up in liquid paraffin, feathers plucked from breast and virus rubbed on. Two pigeons vaccinated with 10 per cent. virus one month old made up in 80 per cent. glycerine in ·85 per cent. salt solution applied to the breast. Two pigeons vaccinated with 20 per cent. virus one month old in liquid paraffin, applied to breast. Two pigeons vaccinated with 20 per cent. virus one month old made up in 80 per cent. glycerine in ·85 per cent. salt solution.
17.11.31 to 11.12.31	Follicles swollen, crust formation in all birds. Three birds developed typical pigeon pox lesions. These were photographed.

Results.—Growths were obtained on all 8 birds. Birds vaccinated with glycerine saline virus generally showed a more profuse growth, typical of pigeon pox. Those vaccinated with liquid paraffin virus showed a less profuse growth that quickly dried up on the birds. The birds that developed lesions were two birds belonging to the 20 per cent. virus in liquid paraffin group, and one bird in 10 per cent. virus in liquid paraffin group.

Conclusions.—It appears that the powdered virus material in 10-20 per cent. strength, made up with glycerine saline solution, becomes somewhat attentuated for pigeons. It still gives a good growth on the pigeons vaccinated for virus production.

Experiment 429*f*.—To propagate the Rossi strain on susceptible piegons.

Date.	Remarks.
25.11.31	Two pigeons vaccinated with 20 per cent. virus material one month old made up with 80 per cent. glycerine in ·85 per cent. salt solution. Breasts plucked and virus solution rubbed on.
2.12.31	Good commencing reactions, follicles much swollen and reddened.
8.12.31	Whole surface of breast covered with soft yellow brownish crust.
11.12.31	Good growths on both birds, material collected.

Results.—Good growths obtained from both birds. It appears as if 20 per cent. virus in glycerine saline gives good results and does not kill birds, giving one an opportunity to collect vaccine.

For virus production one is now using a 10-20 per cent. strength solution of virus material in glycerine saline.

More recent results have shown that a 5 per cent. strength of virus in glycerine saline gives a good growth of virus material and does not kill the bird, thus giving one a chance to obtain a good growth. It is intended in future to try this strength out for production of pigeon pox vaccine on a large scale.

Summary.

1. True pigeon pox appears to be unknown in South Africa.

2. Virus material 10 months old imported from England was still markedly virulent on arrival. It was capable of setting up the disease in birds here.

3. The immediate transference of moist scabs from an affected bird to another bird by passage gradually results in an increase of the virulence of the virus.

4. Virus material giving the best results was dried for from 24-48 hours in an incubator at 37° C. It was then bottled and stored in a dark cupboard.

5. Virus material should be about a month old before it is applied to a bird for virus production.

6. Virus material should, before use, be thoroughly powdered and intimately mixed with the glycerine saline solution.

7. Glycerine saline solution appears to be superior to either pure glycerine or liquid paraffin as a vehicle for suspending the virus material in.

8. Pigeon pox crusts should be removed while yellowish and still soft, usually from the 12th to 16th day after vaccination.

9. It appears as if a 5 per cent. strength of virus material when applied to the plucked breasts of pigeons gives good results.

10. Scarification of the breast of a pigeon, after plucking, prior to rubbing in of virus material is not necessary in order to obtain good results.

11. From two to three grammes of virus material is obtained from each pigeon.

12. From the way all birds have reacted to the artificial infection of pigeon pox one would suggest that pigeon pox is not common. So far no birds have failed to react. In fowl pox, out of every batch of young cockerels vaccinated, a few always fail to react.

(c) Vaccination of Fowls.

Quite a number of methods have been utilized for transferring the virus of fowl pox or pigeon pox to fowls in an attempt to set up immunity against fowl pox. Beach (1927) injected his vaccine by the subcutaneous route. In 1929 the same author used what he called the " follicle injection " method or what is known as the de Blieck and van Heelsbergen method. Previously, pulling out of the feathers of the leg, scarification and rubbing in of the virus had been a common one. This method has, in our hands, with fowl pox virus yielded good results and is the method still employed at the moment in South Africa. This was carried out by Mitchell (1923) at Pietermaritzburg, but never published.

Johnson (1927) reported on the application of vaccine by the " follicle " method, viz., plucking a few feathers out of the limb and then painting one or more follicles with vaccine by means of a camel's hair brush. The same author (1929) drew attention to the " stick " method, viz., the puncturing of the skin by means of a sharp pointed stick that had been dipped in the vaccine. The skin was pricked once or twice. Stafseth (1929) utilized the " skin puncture " method. The skin was punctured on the inside of the web of the wing by means of a pair of small pointed scissors held open about 4 mm. by a wrapping of cord. This is simply a modification of the " stick " method.

De Blieck (1927) stated that he and Van Heelsbergen had tried the subcutaneous and intravenous routes but had found the intracutaneous method the best and deduced, logically so, that in a natural case the lesions were found on the skin or mucous membranes and naturally to obtain an immunity, an eruption must take place on the skin or mucous membrane.

The method employed throughout this work was the one advocated by de Blieck and van Heelsbergen, viz., a number of feathers were pulled out of the upper part of the limb a few inches above the Tibio-tarsal joint and the vaccine was applied to the plucked area. This answers excellently where the birds are from four to six weeks of age. In the case of young chickens, one to two weeks of age, this part of the limb has only " down " feathers with very small follicles, so it is advisable to use a site slightly above the usual one where the feather follicles are larger. Johnson (1927) raised the question of the difficulty of finding open follicles in fowls that had moulted some time previously. This could be easily overcome by doing the birds prior to moulting. In all birds done here the follicles become noticeably swollen and slightly reddened from about the fourth day. This continues with a slight desquamation up to the eighth day and usually by the twelfth to the fourteenth day the reaction has been completed.

Chickens of a few days old up to three or four months of age have been vaccinated and in no cases have constitutional symptoms been observed. Similarly in these older birds no moulting has been induced.

The strengths of the vaccine used have been ½ per cent., 1 per cent., 2 per cent., and 3 per cent.

These have been made up with liquid paraffin in most cases and a few batches of vaccine were made up in glycerine. Liquid paraffin was used as a result of the work of Mitchell (1926), who showed that fowl pox virus would remain active up to from three to four weeks, while with glycerine it was not viable after eight to ten days. The virus used was in some cases freshly removed and had been dried in an incubator at 37° C. for from 12-24 hours, while in other cases it was a few days old.

All vaccine used was freshly made and finely powdered up just prior to use.

Results.—From the experimental records in appendix one would conclude:—

(*a*) Vaccines of from ½ to 3 per cent. strength give reactions of more or less similar intensity.

(*b*) No difference in the intensity of the reactions was noted when the vaccines were made up with glycerine or liquid paraffin.

(*c*) No constitutional symptoms were observed in any of the birds vaccinated.

(*d*) Birds of from a few days old up to four months were vaccinated.

(*e*) The birds used were, for the most part, White Leghorns, the remainder were cross-bred Indian Games.

IMMUNITY TESTS.

Birds of 1 week up to 4 months old were vaccinated with pigeon pox vaccine and then, commencing one month after vaccination, these birds were tested for immunity by either placing them in contact with natural cases or artificially infecting them with fowl pox by scarification of the comb or inside of the mouth or on the thigh. All birds in these experiments were kept in cages inside a large roofed compound. Four birds were allowed to a pen.

(*a*) Birds artificially infected with Fowl Pox after being Vaccinated with Pigeon Pox Virus.

Experiment 440.

Date.—21.10.31.

Object.—To test out immunity of vaccinated White Leghorn chickens against artificial infection.

Method.—7 chickens 3-4 months old, vaccinated 14.9.31 with pigeon pox vaccine 1 per cent. strength, numbered 1-7.

4 chickens, 3-5 weeks old, vaccinated 14.9.31 with pigeon pox vaccine 1 per cent. strength, numbered 14-17.

2 chickens, 4 months old, vaccinated 14.9.31 with pigeon pox vaccine, 0·5 per cent. strength, numbered 8-9.

4 chickens, 2 months old, vaccinated 14.9.31 with pigeon pox vaccine, 0·5 per cent. strength, numbered 10-13.

Controls, 49 roosters 4 months old, not vaccinated with pigeon pox vaccine.

Five weeks after vaccination (21.10.31) these birds were artificially infected with a concentrated virus emulsion of fowl pox by scarifying either comb or mouth and in each case virus was rubbed in. (See Table 1.)

Results.—All birds by the fifth day showed lesions of fowl pox. Out of six birds vaccinated with 0·5 per cent. vaccine three showed a marked nasal discharge, were visibly ill and one died 11 days after being artifically infected with fowl pox. By the 13th day the majority of immunized fowls had practically recovered. On the 19th day one fowl, No. 4, had died showing typical roup lesions, while two birds, Nos. 8 and 12, still had marked lesions on the comb. The rest of the birds showed no lesions; there remained a nasal discharge in some cases.

Of the controls all showed very marked lesions on the combs, many were unwilling to stand and lay with their heads hidden under their wings. They were visibly ill.

Conclusions.—There is no doubt that the birds immunized with 1 per cent. pigeon pox vaccine have a fair degree of immunity. Their lesions did not spread beyond the scarified areas except in fowl 15. The growth of scab formation on comb was not typical of fowl pox and came off very easily and very soon. Their general health was never affected. The same conclusions apply equally to those birds which were infected in the mouth.

Fowls immunized with 0·5 per cent. pigeon pox vaccine had also a degree of immunity but not so good as those vaccinated with 1 per cent. pigeon pox vaccine.

Experiment 432.

Date.—21.10.31.

Object.—To test out immunity of vaccinated Indian Game chickens against artificial infection.

Method.—3 chickens, 1 month to 6 weeks old, vaccinated on 29.8.31 on comb by scarification and rubbing on of concentrated emulsion of pigeon pox virus, numbered 5-7.

4 chickens, 1 month to 6 weeks old, vaccinated on 29.8.31 on thigh by usual method with concentrated emulsion of pigeon pox virus, numbered 1-4.

Controls 49 birds, 4 months old, not vaccinated with pigeon pox vaccine.

Seven weeks after vaccination (21.10.31) these birds were artificially infected with a concentrated virus emulsion of fowl pox by scarifying either comb or mouth and rubbing in virus material. (See Table 2.)

Results.—Four birds had no reactions; this was possibly due to an earlier slight attack of roup prior to vaccination with pigeon pox virus. (See Experiment 432, vaccination of fowls.) The other birds had slight reactions, from which they soon recovered.

Conclusions.—These birds had a degree of immunity at time of vaccination. These results are similar to Experiment 440. Even by using a concentrated pigeon pox virus emulsion a complete immunity is not given.

Experiment 433.

Date.—21.10.31.

Object.—To test out immunity of vaccinated Indian Game chickens against artificial infection.

Method.—7 chickens, 3 months old, vaccinated on 6.9.31 on leg with 2 per cent. pigeon pox vaccine, numbered 8-14.

6 chickens, 3 months old, vaccinated on 6.9.31 on leg with 1 per cent. pigeon pox vaccine, numbered 15-20.

Controls: 49 birds, 4 months old, not vaccinated with pigeon pox vaccine.

Six weeks after vaccination, 21.10.31, these birds were artificially infected with a concentrated fowl pox virus emulsion by scarifying either combs or mouth and rubbing in of the virus emulsion. (See Table 3.)

Results.—Similar to Experiment 440; all birds reacted. The reactions were slight, soon passed over and no general disturbance of health was seen.

Conclusions.—A 2 per cent. vaccine of pigeon pox virus does not appear to be capable of producing a stronger immunity against fowl pox than does a 1 per cent. strength.

Experiments 441, 443, *and* 445.

Date.—17.11.31.

Object.—To test out immunity of vaccinated White Leghorn chickens against artificial infection.

Method.—4 chickens, 2-4 months old, vaccinated on left leg with 1 per cent. pigeon pox virus (usual method) numbered 441.

4 chickens, 1 month old, vaccinated on left leg with 1 per cent. pigeon pox virus (usual method), numbered 443.

12 chickens, 3 weeks old, vaccinated on left leg with 1 per cent. pigeon pox virus (usual method), numbered 444.

Seven weeks later the feathers of right leg were plucked and a concentrated fowl pox virus was rubbed into open follicles. (See Table 4.)

Results.—A slight positive reaction to fowl pox took place which cleared up in roughly a week's time.

Conclusions.—A certain degree of immunity is conferred by 1 per cent. pigeon pox vaccine—similar to previous experiments.

The reaction here was over in seven days' time. This is 4-6 days shorter than the time taken when susceptible chickens are treated in a similar manner with fowl pox vaccine 1 per cent.

Summary of Conclusions.

It appears that 1 per cent. pigeon pox vaccine protects to a certain extent against a heavy artificial infection with fowl pox virus.

A 2 per cent. pigeon pox vaccine also protects but apparently no more than does a 1 per cent. strength.

A 0·5 per cent pigeon pox vaccine protects but in a lesser degree than does a 1 per cent, strength.

Chickens are not likely to obtain as heavy an infection under natural conditions as was used by us in these experiments.

These results are in agreement with those of Doyle's (1930), but different from those of Lahaye (1928).

(*b*) Birds after being Vaccinated with Pigeon Pox Virus placed with Naturally Infected Birds.

All birds in these experiments had been vaccinated with pigeon pox virus and were kept in pens which were never cleaned, so as to maintain infection the whole time. We were able to get cases among young birds suffering from roup affecting the nasal chambers and the eyes, and also birds showing typical fowl pox nodules on heads and combs. In some cases we artificially infected some birds and when the reaction was progressing they were also used as infected birds.

Experiment 445a.

Date.—2.11.31.

Object.—To test the immunity of vaccinated birds when placed in contact with natural cases of fowl pox.

Method.—12 chickens, 5 weeks old, vaccinated 3.10.31 with 1 per cent. pigeon pox vaccine, numbered 1-12.

8 chickens, all natural cases of nasal, ocular and cutaneous fowl pox, numbered 19-26.

6 chickens, not vaccinated, numbered 13-18.

A month after vaccination, 2.11.31, the three groups were placed in one pen. (See Table 5.)

Results.—By the 13th day only one bird, No. 2, had shown a nasal discharge; by the 17th day all had a slight nasal discharge with the exception of Nos. 5 and 11. All the immunized birds, in spite of their slight nasal discharge, were bright and in good health.

Control birds had profuse nasal discharges, were dull, and had the characteristic " roupy " smell. Three of these birds died of typical roup.

Conclusions.—A complete immunity was not obtained, although one may claim no fowl pox nodules appeared, and no typical "roupy" eye was seen. The nasal discharge only appeared among the immunized birds after two weeks of contact.

No generalization of the disease was seen in the immunized birds.

Birds under six weeks when vaccinated with pigeon pox virus do obtain a good degree of immunity—this is in contrast with the use of fowl pox vaccine on birds of under six weeks. In this case it was claimed by Mitchell (1926) that no immunity was obtained.

Experiment 446.

Date.—4.11.31.

Object.—To test out immunity of vaccinated birds when placed in contact with natural cases of fowl pox.

Method.—6 chickens, 1 month old, vaccinated on 3.10.31 with 1 per cent. pigeon pox vaccine, numbered 1-6.

2 young fowls with heavy growths of artificially produced fowl pox on combs, numbered 13 and 14.

6 chickens susceptible—never vaccinated, numbered 7-12.

2 young fowls suffering from eye roup.

A month after vaccination the six immunized chickens and two fowls artificially infected were placed together in pen. Six days later susceptible fowls were placed with them and on 21st day the two natural eye roup cases joined them. It was decided to keep these birds for two months in the experiment. (See Table 6.)

Results.—By the 12th day three immunized birds showed an isolated fowl pox nodule on the comb—this was probably fly or mosquito transmitted.

By the 34th day two immunized birds had died of chronic coccidiosis, while of the controls one died of definite roup, two had fowl pox lesions on comb and two had nasal discharges.

By the 54th day all but one of the controls had definite roup lesions, while of the immunized birds two were perfectly normal and two had very slight nasal discharges.

By the 61st day all controls were definitely affected.

It is interesting to note that on the 43rd day bird No. 9 developed a swollen left wattle and on the 61st day bird No. 10 developed a swollen wattle also. These have since become shrivelled up and indurated.

Conclusions.—There seems no doubt that this test proves that vaccinated birds do acquire a good immunity against natural outbreaks.

Experiment 449.

Date.—23.11.31.

Object.—To test the immunity of vaccinated birds when placed in contact with natural cases of fowl pox.

Method.—7 chickens, 1 month old, vaccinated on 3.10.31 with 1 per cent. pigeon pox vaccine, numbered 7-13.

6 chickens, 1 month old, not vaccinated as controls, numbered 1-6.

Seven weeks after vaccination these two groups of chickens were placed in contact with 3 naturally infected cases of eye roup. (See Table 7.)

Results.—By the 24th day all the controls except two had definite fowl pox lesions, while one of the immunized birds had a small lesion in mouth. By the 35th day five of the six controls had died of either true chicken pox or the roup form of chicken pox; of the immunized birds two had slight mouth lesions and one had died of chronic coccidiosis. By the 42nd day the last control had died of chicken pox.

Conclusion.—The vaccinated birds have a good immunity against a natural outbreak.

Experiment 445B.

Date.—3.10.31.

Object.—To test the immunity of vaccinated birds when placed in contact with natural cases of fowl pox.

Method.—36 chickens vaccinated at 1 week old with 1 per cent. pigeon pox virus.

Placed in open run with affected birds in pen alongside and in front of them. Distance between pens, three feet.

Results.—None of these birds have contracted any form of chicken pox although in indirect contact for over four months.

Conclusions.—There was every possibility of flies and mosquitoes transmitting infection under conditions similar to what obtains on a farm, but no cases of fowl pox have been seen.

SUMMARY AND CONCLUSIONS.

1. Experiments were carried out to obtain a suitable preventative against fowl pox in poultry.

2. It was endeavoured to ascertain at what strength the pigeon pox virus could be used on pigeons to obtain a suitable growth of pigeon pox virus for vaccine preparation.

3. Attempts were made to find out what strength of vaccine could be used to set up a good immunity to fowl pox.

4. Pigeon pox vaccine produced a good immunity against natural cases of fowl pox, but not so good an immunity against artificial infections with fowl pox virus.

5. Young birds of a week old can be vaccinated with pigeon pox vaccine with safety and in no birds inoculated were any constitutional symptoms observed.

I would like to record my appreciation of the help given me by my assistant, Mr. Hill.

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EXPERIMENT 432A.—24.8.31.

PIGEON POX.

"*Rossi*" *strain.*—Dried in incubator in open Petri dish; collected on 20.8.31. Concentrated in glycerine.

Object.—To ascertain reaction of pigeon pox virus on susceptible healthy chickens, cross-bred Game, and to test out subsequent immunity. 1 month to 6 weeks.

Note.—Suspicion of having been in contact with roup.

Method.—4 birds, Nos. 1 to 4, vaccinated on thigh with concentrated virus E. 429 (Rossi) strain.

Date.	Remarks.
29.8.31	Lines of scarification clearly defined, few feather follicles swollen.
31.8.31	Feather follicles much swollen, reddened, whole area of scarification thickened, with some discreet yellow vesicles.
1.9.31	Vesicles drying up. Feather follicles, no change.
3.9.31	Reaction almost complete, feather follicles considerably reduced.
8.9.31	Feather follicles receding.
12.9.31	Lesions dried up, scab flaked off.

Results.—Positive reactions.

EXPERIMENT 433A.—3.9.31.

PIGEON POX TO FOWLS.

Generation Virus 11·2 per cent. Vaccine.

"*Rossi*" *strain.*—3 days old—dried in incubator for 12 hours.

Object.—To determine effect of pigeon vaccine on susceptible healthy chickens (cross-bred Games), 3 months old, and to test subsequent immunity.

Method.—7 birds, Nos. 8 to 14, scarified and vaccinated on thigh with 2 per cent. suspension of powdered scab in liquid paraffin.

Date.	Remarks.
6.9.31	Feather follicles swollen whole area of scarification yellowish with several discreet vesicles around a brownish crust.
8.9.31	Reaction slightly more marked—feather follicles reddened, whole area of vaccination in some cases swollen.
10.9.31	Swelling considerably reduced, crust flaking off.
12.9.31	Reaction complete.

Results.—Positive reactions.

EXPERIMENT 433B.—3.9.31.

Generation Virus 11. 1 per cent. Vaccine.

" *Rossi* " *strain.*—3 days old—dried in incubator 12 hours.

Method.—6 birds, Nos. 15-20, scarified and vaccinated on thigh with 1 per cent. suspension of powdered scab in liquid paraffin. 3 months old.

Date.	Remarks.
6.9.31	Feather follicles swollen, area of scarification yellowish with discreet vesicles around raised brownish crust.
8.9.31	Reaction more marked than in those vaccinated with 2 per cent. vaccine ; feather follicles reddened and swollen.
10.9.31	Follicles reduced in size ; crust commencing to flake off.
12.9.31	Reaction complete.

Results.—Positive reactions.

EXPERIMENT 434A.—3.9.31.

PIGEON POX TO FOWLS.

" *Rossi* " *strain Generation* 11 *Virus.*—3 days old—dried in incubator in 12 hours.

Method.—2 chickens, 2-3 months, Nos. 1 and 2, scarified and vaccinated with 2 per cent. suspension powdered scab in liquid paraffin.

Date.	Remarks.
6.9.31	Commencing reaction : thin brownish crust, follicles show slight swelling.
8.9.31	Few vesicles formed, feather follicles raised and slightly reddened.
9.9.31	Condition unchanged.
10.9.31	Large brownish crust, reddening of feather follicles less marked.
12.9.31	Reaction complete. Material collected.

Results.—Positive reactions.

EXPERIMENT 434B.—3.9.31.

PIGEON POX TO FOWLS.

" *Rossi* " *strain—Generation* 11 *Virus.*—3 days old, dried in incubator 12 hours.

Method.—2 chickens, Nos. 3 and 4, scarified and vaccinated with 1 per cent. suspension powdered scab in liquid paraffin.

Date.	Remarks.
6.9.31	Commencing reaction : thin brownish crust, follicles show some swelling.
8.9.31	Few vesicles formed, large brownish crust, thigh somewhat swollen and inflamed.
9.9.31	Reaction slightly more marked—otherwise no change.
10.9.31	No change.
12.9.31	Reaction complete. Material collected.

Results.—Positive reactions.

EXPERIMENT 434c.—3.9.31.

PIGEON POX TO FOWLS.

"*Rossi*" *strain Generation* 11 Virus.—3 days old, dried in incubator 12 hours.

Method.—1 chicken, No. 5, feathers plucked and vaccinated over this area with 2 per cent. suspension powdered scabs in liquid paraffin.

Date.	Remarks.
6.9.31	Feather follicles show slight swelling.
8.9.31	Marked swelling of feather follicles, each follicles much reddened and hard to the touch.
9.9.31	Marked reaction, whole area of thigh shows some reddening and follicles much increased in size.
10.9.31	No change.
12.9.31	Follicles less reddened, and considerably reduced in size. Reaction complete.

Results.—Positive reactions.

EXPERIMENT 441.—20.9.31.

"*Rossi*" *strain, 3rd Generation.*—Stored room temperature, crust formation for 1 week.

Object.—To observe reaction on chickens 3-4 months old and to test out subsequent immunity to fowl pox.

Method.—4 chickens. Feathers removed from thigh and leg and vaccinated with 1 per cent. virus (E. 429), freshly prepared in liquid paraffin.

Date.	Remarks.
24.9.31	Commencing reaction, some follicles swollen.
26.9.31	Reaction more marked, some reddening of plucked area, follicles much swollen.
28.9.31	Marked papulation in three of the birds. The fourth bird probably not sufficiently vaccinated, only a few follicles swollen.
30.9.31	Follicles much reduced in size. Reaction nearing completion.
2.10.31	Reaction complete.

Results.—Positive reactions.

EXPERIMENT 443.—24.9.31.

"*Rossi*" *strain*, *3rd Generation.*—Stored room temperature, crust formation for 1 week emulsified 1 per cent. in liquid paraffin and again stored for 4 days before use.

Object.—To observe reaction on chickens 1 month old and to test out subsequent immunity to fowl pox.

Method.—4 chickens. Feathers removed from thigh and leg and vaccinated with 1 per cent. virus (E. 429) in liquid paraffin.

Date.	Remarks.
26.9.31	Some slight reddening of skin; thigh slightly swollen.
28.9.31	Good commencing reaction; follicles swollen and assuming a yellowish colour.
29.9.31	Marked reaction; follicles much swollen with typical yellowish crust formation at tip of each.
30.9.31	Several follicles weeping at apex of growth; others dry.
2.10.31	Follicles slightly reduced in size.
4.10.31	Follicles considerably reduced. Reaction practically complete. All birds remaining quite healthy.
5.10.31	Reaction complete.

Results.—Positive reactions.

EXPERIMENT 440.—14.9.31.

PIGEON POX TO FOWLS.

0·5 PER CENT. VIRUS IN LIQUID PARAFFIN.

1ST GENERATION.

"*Rossi*" *strain x E.* 429 *of* 20.8.31, *Generation* 1.—Material dried in incubator 12 hours and stored at room temperature for 25 days.

Method.—2 birds, Nos. 8 and 9, 4 months old, and 4 chickens, Nos. 10-13, 2 months old. Feathers pulled from thigh and 0·5 per cent. virus rubbed on.

Date.	Remarks.
18.9.31	Follicles show severe slight swelling.
19.9.31	2 old birds show marked swelling of follicles and desquamation; 4 younger birds good commencing reaction; less marked than in older birds.
22.9.31	Follicles much swollen and reddened.
24.9.31	Follicles diminishing, all birds quite healthy.
26.9.31	Reaction complete.

Results.—Positive reactions.

EXPERIMENT 440.—14.9.31.

PIGEON POX TO FOWLS.

1 Per cent. Virus in Liquid Paraffin.

1st *Generation.*

"*Rossi*" *strain x E.* 429 *of* 20.8.31. *Generation* 1.—Material dried in incubator 12 hours and stored at room temperature for 25 days.

Method.—Nos. 1-7, chickens 3-4 months. Feathers pulled from thigh and 1 per cent. virus rubbed on.

Nos. 14-17, 4 chickens, 3 weeks to 5 weeks. Feathers pulled from thigh and 1 per cent. virus rubbed on.

Date.	Remarks.
18.9.31	7 chickens—follicles commencing to swell.
	4 chickens—follicles commencing to swell.
19.9.31	The 7 chickens show marked swelling of follicles and desquamation.
	The 4 chickens show commencing reaction, 3 marked, 1 slight.
22.9.31	Follicles considerably swollen and reddened.
24.9.31	Follicles diminishing. All birds quite healthy.
26.9.31	Reaction complete.

Results.—Positive reactions.

EXPERIMENT 444.—29.9.31.

"*Rossi*" *strain, 3rd Generation.*—Stored at room temperature 15 days crust formation.

Object.—To observe reaction on chickens 3 weeks old and to test out subsequent immunity to fowl pox.

Method.—(*a*) 6 chickens (dark). Feathers removed from breast and vaccinated with 1 per cent. virus (429) in liquid paraffin freshly prepared.

(*b*) 6 chickens (light), vaccinated with same virus on thigh and leg.

Date.	Remarks.
2.10.31	A. Very slight commencing reaction, follicles slightly swollen with some reddening of breast.
	B. Very slight commencing reaction, follicles slightly swollen, flesh reddening and in three cases thight slightly swollen.
5.10.31	All birds show marked swelling of follicles, the reaction appearing as golden-yellow nodules, some few weeping at apex.
7.10.31	Good reaction in all birds, no difference in either method of vaccination.
8.10.31	Swelling of follicles subsiding.
10.10.31	Reaction almost complete. Birds remain quite healthy and active.
13.10.31	Reaction complete.

Results.—Positive reactions.

EXPERIMENT 445.—3.10.31.

PIGEON POX TO FOWLS.

"Rossi" strain, 4th Generation.

Vaccine Test.—To determine effect of vaccination on chickens 1 week old and to test out subsequent immunity from 1 month upwards—following vaccination.

Method.—Feathers pulled from thigh of 48 chickens vaccinated with 1 per cent. vaccine in liquid paraffin with freshly removed scabs from Pigeon No. 4.

Date.	Remarks.
6.10.31	All chickens show swelling of thigh with commencing swelling of follicles.
8.10.31	Good reactions, follicles much swollen, appearing as golden yellow nodules. Some weeping at apex. All birds apparently healthy.
10.10.31	Reaction more marked. marked thickening of thighs and legs; whole area inflamed and reddened.
12.10.31	Reaction markedly subsided; follicles in many cases almost normal in size.
14.10.31	Reaction complete.

Results.—Good reactions.

Conclusion.—A marked local reaction with much thickening of thighs and legs. No symptoms of ill-health apparent whatever during the reaction, the whole flock active and bright.

EXPERIMENT 446.—3.10.31.

PIGEON POX TO FOWLS.

"Rossi" strain, 4th Generation.

Vaccine Test.—To determine effect of vaccination on chickens 1 month old and to test out subsequent immunity from 1 month upwards, following vaccination.

Method.—Feathers pulled off over thigh from 50 chickens and vaccinated with 1 per cent. vaccine in liquid paraffin with freshly prepared scabs removed from Pigeon No. 4.

Date.	Remarks.
6.10.31	All chickens show swelling of thigh with commencing swelling of follicles.
8.10.31	Good reactions. Follicles much swollen, appearing as golden-yellow nodules. some weeping at apex. All birds healthy.
10.10.31	No change.
12.10.31	Follicles much reduced in size, drying off.
14.10.31	Reaction complete, leaving a few reddened areas only.

Result and Conclusions.—A marked reaction with severe thickening of legs and thighs. The birds showed no ill-effects whatever, remaining active and bright throughout the reaction.

TABLE 1.

No. of Fowl.	Age.	Date of Vaccination.	Date of Immunity Test.		Strength of Vaccine.	Results. 5th Day.	Results. 13th Day.	Results. 19th Day.
					%			
1	3–4 months....	14.9.31	21.10.31	c.	1	+ c healthy.	+ c healthy } Growth on combs not typical of Fowl Pox lesions peels off easily.	Normal, no lesions left } All in good health.
2	,, ...	,,	,,	c.	1	+ + c healthy.	+ + c healthy	Normal, no lesions left
3	,, ...	,,	,,	c.	1	+ + c healthy.	+ + c healthy	Normal, no lesions left
4	,, ...	,,	,,	c.	1	+ c healthy.	+ c healthy	Nasal discharge, eye affected, typ. Roup, died 16.11.31.
5	,, ...	,,	,,	c.	1	+ c healthy.	+ c healthy	Normal, no lesions left.
6	,, ...	,,	,,	c.	1	+ c healthy. Slight nasal discharge on 21.10.31	+ c healthy	Normal, no lesions left, very slight nasal discharge, bird healthy.
7	,, ...	,,	,,	c.	1	+ c healthy, slight nasal discharge 21.10.31	Slight nasal discharge, comb lesions gone, health good	Normal, no lesions left.
8	4 months......	,,	,,	c.	·5	+ + c Dull.	+ + c healthy.	+ c Scabs flaking off.
9	,, ...	,,	,,	c.	·5	+ c healthy.	+ c Slight nasal discharge typ. smell.	Scabs off.
10	2 months......	,,	,,	c.	·5	+ c healthy. Nasal discharge on 21.10.31.	Slight nasal discharge typ. smell	Nasal discharge.
11	,, ...	,,	,,	m.	·5	+ + m dull, lachrymation, swelling of eyelids, char. roup smell, nasal discharge on 21.10.31.	Died 1.11.31 Gen. Roup.	
12	,, ...	,,	,,	c.	·5	+ mc, dull, 2 diphth. patches mouth, char. roup smell.	+ c slight nasal discharge, loss of condition.	+ c marked nasal discharge, visibly ill.
13	,, ...	,,	,,	c.	·5	+ c healthy.	+ c healthy.	Scabs off.
14	3–5 weeks.....	,,	,,	c.	1	+ + c healthy.	+ c healthy.	Comb lesions nearly diasppeared.
15	,, ...	,,	,,	m.	1	+ + m healthy } No spread beyond scarified area.	Normal healthy.	Normal, no lesions } All in good health.
16	,, ...	,,	,,	m.	1	+ + m healthy	Normal healthy.	Normal, no lesions
17	,, ...	,,	,,	m.	1	+ + m healthy	Normal healthy.	Normal, no lesions
—	49 Birds 4 months	Controls...	,,	c.	Controls	+ + + c dull except 4 n.u.	+ + + c very dull.	+ + + c, many unwilling to stand, visibly ill, hiding heads under wings.

m. = mouth. c. = comb. + = small lesion. + + = two small lesions. + + + = more than two lesions.

Table 2.

No. of Fowl.	Age.	Date of Vaccination.	Date of Immunity Test.		Strength of Vaccine.	Results. 5th Day.	Results. 13th Day.	Results. 19th Day.
1	1 month to 6 weeks	29.8.31	21.10.31	m.	Conc. on thigh	+ m. Had not spread from scarified area.	+ m, original area slightly affected.	+ m, very small patch left.
2	..	,,	,,	m.	,,	+ + m. One small patch in throat, healthy.	Complete recovery.	Complete recovery.
3	,,	,,	,,	c.	,,	No reaction.	No reaction.	No reaction.
4	,,	,,	,,	m.	,,	+ m Slightly spread beyond scarification site. Healthy.	+ m. Patches still present, clearing.	Completely recovered.
5	,,	,,	,,	m.	Conc. on comb	No reaction.	No reaction.	Completely recovered.
6	,,	,,	,,	c.	,,	No reaction.	No reaction.	Completely recovered.
7	,,	,,	,,	c.	,,	No reaction.	No reaction.	Completely recovered.
—	49 Birds 4 months	Controls...	,,	c.	,,	+ + + comb, dull.	+ + + comb, very dull.	+ + + comb, visibly ill.

m. = mouth. c. = comb. + = small lesion. + + = two small lesions. + + + = more than two lesions.

Table 3.

No. of Fowl.	Age.	Date of Vaccination.	Date of Immunity Test.		Strength of Vaccine.	Results. 5th Day.	Results. 13th Day.	Results. 19th Day.
8	3 months....	6.9.31	21.10.31	m.	2% on thigh	+ m, confined to scarified area, no smell, healthy.	+ m, getting smaller.	Pock mark remains only.
9	,, ...	,,	,,	m.	,,	+ mc spread to mouth corner, patch on comb.	Bird died. Internal haemorrhage, 1.11.31.	—
10	,, ...	,,	,,	m.	,,	+ m confined to scarified area, no smell, healthy.	Completely recovered.	Recovery.
11	,, ...	,,	,,	m.	,,	+ m slight spread, bird healthy.	+ m patch almost gone.	Pock mark remains only.
12	,, ...	,,	,,	m.	,,	+ m confined to scarified area, healthy.	+ m patch almost gone.	Recovery.
13	,, ...	,,	,,	c.	,,	No reaction.	No reaction.	Recovery.
14	,, ...	,,	,,	m.	,,	+ m confined to scarified area.	+ m patch almost gone.	Recovery.
15	,, ...	,,	,,	m.	1% on thigh	+ m confined to scarified area.	Completely recovered.	Recovery.
16	,, ...	,,	,,	c.	,,	+ c slight not typical Fowl Pox scab, healthy	+ m. Minute specks, bird healthy.	Recovery.
17	,, ...	,,	,,	c.	,,	+ m one small patch, no reaction comb.	Completely recovered.	Recovery.
18	,, ...	,,	,,	c.	,,	No reaction.	No reaction.	Recovery.
19	,, ...	,,	,,	c.	,,	+ c, not typical Fowl Pox scab, healthy.	Completely recovered.	Recovery.
20	,, ...	,,	,,	c.	,,	+ m, slight, no reaction comb.	Completely recovered.	Recovery.
—	49 Birds, 4 months	Controls	,,	c.	,,	+++ c dull.	+++ comb very dull.	+++ c visibly ill.

m = mouth. c = comb. + = one lesion. ++ = two lesions. +++ = more than two lesions.

Table 4.

Expt. No.	Age.	Date of Vaccination.	Date of Immunity Test.	Nos. of Chickens.	Results. 2nd Day.	Results. 6th Day.
444	3 weeks.....	29.9.31	17.11.31	12	Follicles enlarged.	Reactions passing off. Limbs almost normal. Birds in good health.
441	2–4 months..	20.9.31	17.11.31	4	Follicles enlarged.	Reactions passing off. Limbs almost normal. Birds in good health.
443	1 month.....	24.9.31	17.11.31	4	Follicles enlarged.	Reactions passing off. Limbs almost normal. Birds in good health.

TABLE 5.

No. of Fowl.	Age.	Date of Vaccination.	Strength of Vaccine.	Date of Immunity Test.	Results. 13th Day.	14th Day.	17th Day.	21st Day.
1	5 weeks...	3.10.31	% 1	2.11.31	—	+ n	+ n good health.	+ n good health.
2	,, ...	,,	,,	,,	+ n	+ n	+ n good health.	++ n good health.
3	,, ...	,,	,	,,	—	+ n	+ n good health.	+ n very slight.
4	,, ...	,,	,,	,,	—	—	+ n good health.	+ n good health.
5	,, ...	,,	,,	,,	—	—	good health.	good health.
6	,, ...	,,	,,	,,	—	+ n	good health.	+ n very slight.
7	,, ...	,,	,,	,,	—	+ n	+ n good health.	+ n good health.
8	,, ...	,,	,,	,,	—	+ n	++ n good health.	+ n good health.
9	,, ...	,,	,,	,,	—	—	+ n good health.	+ n good health.
10	,, ...	,,	,,	,,	—	+ n	+ n good health.	+ n good health.
11	,, ...	,,	,,	,,	—	—	good health.	good health.
12	,, ...	,,	,,	,,	—	+ n	+ n good health.	+ n good health.
13	,, ...	Control....	—	,,	+ n	+ n dull	++ n dull.	Died 20th day. Pox form Roup.
14	,, ...	,,	—	,,	+ n	++ n dull	+ n dull.	Died 20th day. Pox form Roup.
15	,, ...	,,	—	,,	+ n	+ n dull.	++ n (Char. Roup smell)	++ n both eyes affected, marasmus. Died 25th day.
16	,, ...	,,	—	,,	+ n	+ n dull.	++ n (Char. Roup smell)	++ n very dull.
17	,, ...	,,	—	,,	—	+ n dull.	+ n (Commenc. occular lesion.	++ n, gurgling in throat.
18	,, ...	,,	—	,,	—	+ n dull.	—	++ n very dull.
19	,, ...	Infected...	—	,,	+ n	+ n	+ n.	+ n.
20	,, ...	,,	—	,,	+ n	+ n dull.	+ n.	+ n.
21	,, ...	,,	—	,,	+ n	+ n dull.	+ n.	+ n.
22	7 weeks...	,,	—	,,	+ n.c.	+ n.c. dull.	+ nc	+ nc.
23	,, ...	,,	—	,,	+ c.	+ c dull.	+ nc	+ nc.
24	8 weeks...	,,	—	,,	+ c.	+ c dull.	+ nc	+ nc, eyes involved.
25	5 weeks...	,,	—	,,	+ n.c.	+ nc dull.	+ nc	+ nc, eyes involved.
26	,, ...	,,	—	,,	+ n.c.	+ nc dull.	+ nc	+ nc, eyes involved.

n. = slight nasal discharge. c = lesion comb.

Photograph 1.—Showing growth of pigeon pox virus on breast, lesions round beak, nostrils, and eye.

Photograph 2.—Close view of swollen follicles of breast—result of virus production.

Photograph 3.—Close view of lesions round the eyelid, a few swollen follicles on breast visible.

TABLE 7.

No. of Fowl.	Age.	Date of Vaccination.	Date of Immunity Test.	Strength of Vaccine.	Results.					
					7th Day.	15th Day.	24th Day.	35th Day.	42nd Day.	45th Day.
1	$2\frac{1}{2}$ months	Controls...	23.11.31	—	Nu	Nu	Nu (pale)	Died 28.12.31	—	—
2	,,	,,	,,	—	Nu	Nu	+ c	Died 28.12.31 (Roup)	—	—
3	,,	,,	,,	—	Nu	Nu	+ c ++ m	Died 31.12.31 +c++m+t	—	—
4	,,	,,	,,	—	Nu	Nu	+ c	+ m	Died 4.1.32	—
5	,,	,,	,,	—	Nu	Nu	nu	Died 28.12.31 (Chicken Pox)	—	—
6	,,	,,	,,	—	Nu	Nu	+ c ++ m	Died 31.12.31 (Roup)	—	—
7	,,	3.10.31	,,	1 %	Nu	Nu	Nu	Nu	s.n.d.	s.n.d.
8	,,	,,	,,	,,	Nu	Nu	Nu	Nu	Nu	nu
9	,	,,	,,	,,	Nu	Nu	Nu	+m (slight)	+ m (slight)	m.
10	,,	,,	,,	,,	Nu	Nu	Nu	nu	nu	nu
11	,,	,,	,,	,,	Nu	Nu	+ m (slight)	nu	nu	nu
12	,,	,,	,,	,,	Nu	Nu	nu	+ m (slight)	nu	nu
13	,,	,,	,,	,,	Nu	Nu	nu	Died 28.12.31 (Coccid.)	—	—

m = mouth lesion. c. = comb. t. = throat. s.n.d. = slight nasal discharge. Nu = normal.

Section III.

Bacterial Diseases.

J R. Scheuber The Occurrence of *B. oedematiens* in South Africa.

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

The Occurrence of *B. oedematiens* in South Africa.

By J. R. SCHEUBER, Dr.Med.Vet., Veterinary Research Officer, Onderstepoort.

Introduction.

The purpose of the present note is to record the occurrence of *B. oedematiens* in the Union of South Africa.

The strain described originates from the Aliwal North District of the Cape Province. It was isolated from the head of a sheep, dead from gangrenous oedema following " crow pick ".

The condition referred to as " crow pick " seems to coincide with that described by Edgar (1931) in Australia. According to a verbal communication from Dr. J. G. Bekker, Veterinary Research Officer, Onderstepoort, it occurs in all classes of sheep, but especially in those in low condition and ewes heavy in lamb. Crows usually attack sheep which, for some reason or other, are unable to rise, and they pick at their eyes. The wound becomes infected and a swelling develops, extending from the head down to the front portion of the trunk. The disease always ends fatally.

Morphology.

The rods are rather large, straight, or occasionally slightly curved, with rounded ends. Stained with Gram's method the bacilli measure 3μ–$8\mu \times 0{\cdot}9\mu$–$1{\cdot}6\mu$, with carbol thionin $1{\cdot}8\mu$–$4{\cdot}6\mu \times 0{\cdot}6\mu$–$0{\cdot}9\mu$. The bacilli occur singly, in pairs and in chains up to 20μ long in liquid media (minced meat medium), and up to 70μ long on solid media (serum agar).

Besides these rods of even thickness one finds occasional organisms which are thicker at one end, or even club-shaped.

Apart from these forms a variety of " shades " are present, and become more numerous with the increasing age of the culture. They are usually broader in the middle.

The spores are mostly subterminal, rarely terminal, oval to almost round and in the latter case appear at times slightly flattened at one end. In smears stained with carbol thionin the spores measure $1{\cdot}8\mu$–$2{\cdot}3\mu \times 1\mu$–$1{\cdot}6\mu$.

The organism is motile.

Staining Reactions.

The rods and occasional clubs are gram positive and stain intensively with carbol thionin.

The "shades" are gram negative and stain feebly with carbol thionin. Very often they contain strongly staining points at one or both ends. Occasionally such points occur in larger number in the cell, giving it almost a beaded appearance.

Cultural Characteristics.

The organism is a strict anaerobe. In McIntosh and Fildes' jar it grows on all ordinary media.

Liquid media.

In liquid media it causes turbidity and more or less pronounced gas development. Later a deposit of irregular flakes is formed.

Solid media.

The surface colonies are irregular in shape, have a dense centre and a loose peripheral portion which consists of a network of curly filaments. Some of these filaments appear to be more than twice as thick as others and consist of parallel threads. The size of the colonies on serum agar, after four days' incubation, ranges from about two mm. to one cm. in diameter.

Often the growth consists of a film showing the same structure.

Deep colonies grow $1\frac{1}{2}$ cm. below the surface or ordinary agar, and 7–8 mm. below that of serum agar. After 24 hours' incubation they measure up to $\frac{1}{2}$ mm. in ordinary agar, and nearly 1 mm. in serum agar. The colonies are roundish to irregular, more compact in the centre and looser towards the periphery, which consists of long filaments growing out of the colony in irregular curls. Small colonies appear more fluffy, even snowflake-like.

Biochemical Reactions.

Gelatin is liquefied.

In *Litmus Milk* the reaction turns acid within 24 hours. After about one week's incubation a whitish deposit, which consists of small flakes and granules, has been formed, whilst the clear supernatant fluid is slightly reddish in colour.

Inspissated serum is not liquefied.

Brain is not blackened, and no disagreeable odour is noticeable.

Carbohydrate Fermentation.—These tests appear to be of very little help in the identification of *B. oedematiens.* The results obtained by various workers are greatly at variance:

According to Zeissler (1928) *B. novy* ferments glucose and glycerine, maltose giving variable results.

Robertson (1929) found that glucose, laevulose and maltose are fermented, but cited a number of workers with a considerable variation of opinion.

Turner (1930), after comparing the results in the literature, concluded that glucose seems to be the only substance on which all agreed, and that glycerine was fermented where included in the test, maltose being variable. His own black disease strains all fermented glucose, maltose, laevulose and galactose.

Our strain, on repeated testing, always fermented glucose, maltose and glycerine with marked production of acid and gas (in peptone water with 1 per cent. of carbohydrate and 1 per cent. of Andrade's indicator). Less pronounced signs of fermentation were observed with laevulose, mannose and dextrin in all tests. Galactose gave varying results, and lactose showed either gas development or no reaction at all.

No evidence of fermentation was obtained with arabinose, xylose, rhamnose, saccharose, raffinose, starch, inulin, glycogen, erythrite, adonite, mannite, dulcite, sorbite, inosite, arbutin and salicin.

Pathogenicity and Toxin Production.

The organism is pathogenic for white mice, guinea-pigs, rabbits and sheep. Other animals were not experimented with.

Guinea-pigs injected intramuscularly with virulent cultures in doses ranging between 1 c.c. and 0·01 c.c. died from within 16 hours to 6 days. On post-mortem examination they showed extensive oedematous swellings, especially in the subcutaneous tissues, mostly haemorrhagic near the site of inoculation, and colourless, gelatinous in the more distant portions. As a rule the haemorrhagic changes were more pronounced when larger doses of culture were given, and were very faint, or absent, in guinea-pigs injected with smaller doses.

The organism produces a filtrable toxin, which, injected into the heart, kills guinea-pigs in doses of 0·002 c.c. of sterile filtrate.

Cross Tests with *B. oedematiens*.

The anti-serum used in these tests was prepared with *B. oedematiens*, Cossard, supplied by the Lister Institute. 0·2 c.c. of this anti-serum protected against 40 lethal doses of culture, the largest dose experimented with. 0·05 c.c. of *B. oedematiens* anti-serum neutralized 1 c.c. of toxin, which corresponds to 500 lethal doses.

Conclusions.

The strain isolated from a natural case of " crow pick " in South Africa conforms with the typical *B. oedematiens* in morphology, cultural characteristics and pathogenicity. Anti-serum prepared from a recognized strain of *B. oedematiens* gives a high degree of protection against the local strain.

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Section IV.

Parasitology.

P. J. du Toit and G. A. H. Bedford.	Goat Mange. The Infectivity of Kraals.
H. O. Mönnig ...	Wild Antelopes as Carriers of Nematode Parasites of Domestic Ruminants. Part II.
H. O. Mönnig ...	*Syngamus indicus*: A New Nematode from the Indian Elephant.
R. J. Ortlepp ...	On a New Species of *Tetrameres* (*Tetrameres paradisea* sp. nov.) from Stanley Cranes.
R. J. Ortlepp ...	Some Helminths from South African Chiroptera.
H. H. Curson ...	Distribution of Glossina in the Bechuanaland Protectorate.
G. A. H. Bedford	Description of *Argas striatus*, a new Species of Tick.
G. A. H. Bedford	A Synoptic Check-List and Host-List of the Ectoparasites found on South African Mammalia, Aves, and Reptilia. (Second Edition.)

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

Goat Mange.—The Infectivity of Kraals.

By P. J. DU TOIT, B.A., Dr.Phil., Dr.Med.Vet., D.Sc., Director of Veterinary Services and Animal Industry, and

G. A. H. BEDFORD, F.E.S., Research Officer, Onderstepoort.

In the ninth and tenth reports of the Director of Veterinary Education and Research (1924) an article by one of the present authors (P. J. du Toit) appeared under the title "Sheep Scab: The Infectivity of Kraals". The experiments recorded in that article seemed to prove conclusively that a kraal, grossly infected with scab parasites (*Psoroptes ovis*), if kept free of sheep for a period of seventeen days, will not infect clean sheep.

This doctrine of the non-infectivity of the kraal after a comparatively very short time (16 or 17 days) is now generally accepted by sheep farmers in the case of sheep scab. But in the case of *goat mange* many farmers and other experienced officers still believe that the parasites (*Sarcoptes scabiei caprae*) can survive for very long periods off the host, and that kraals which harboured mangy goats can remain a source of infection for months or even years. The experiment recorded in this paper was undertaken to test the accuracy or otherwise of this belief.

EXPERIMENT S. 3604.

In the main the present experiment was conducted on lines similar to those adopted in the previous experiment. The salient features may be summarized as follows:—

1. *The Kraal.*—In order to make the conditions as severe and as natural as possible, a small stone kraal measuring about 6½ feet square on the inside, was selected for the experiment. Three walls of the kraal were made of rough granite blocks and stood about 4 feet high. The fourth side consisted of coarse wire netting (see Figs. 4, 7 and 8). A rough canvas roof was placed over the kraal to give the animals some protection against the sun.

It was thought that this type of kraal would offer ideal conditions for the mange parasites. Owing to the smallness of the kraal the infected animals would come into close contact with the walls where the cracks and crevices would harbour the parasites.

2. *The Infection.*—Five Angora goats infected with sarcoptic mange were obtained on the 26th September, 1929, and placed in the kraal. These goats were fairly heavily infected, especially on the head (see Figs. 1, 2 and 3) and the infection became gradually worse. On the 13th December, 1929, one goat had to be destroyed on account of poverty, and on the 6th February, 1930, another died of cachexia.

By that time the infection of the kraal must have been very severe. The goats were shedding their hair or rubbing it off against the stone walls. Figure 5 shows the mat of hair on the floor of the kraal and against the walls. It should be added that no bedding or manure was removed from the kraal during the duration of the experiment.

3. *Removal of the Infected Goats.*—The infected goats were left in the kraal from the 26th September, 1929, to the 7th February, 1930, i.e., about 4½ months. On the latter date the three survivors were removed.

Prior to their removal these three goats were shorn and the hair left in the kraal (see Fig. 6). In this way, it was thought the infection of the kraal could be increased.

The kraal was then left empty for seventeen days, i.e. till the 24th February. This was the same period for which the kraal had been left empty in the sheep scab experiment referred to above.

4. *The Test with Clean Goats.*—On the 24th February, 1930, six Angora goats which had been obtained from the Grootfontein School of Agriculture and which were entirely free of mange, were placed in the " infected " kraal.

The kraal which had harboured the infected goats had not been touched during the 17 days. The manure and the bedding on which the infected goats had slept were still in the kraal; the hair from those goats was still clinging to the stone walls and lying in profusion on the ground.

Owing to the smallness of the kraal these goats must have come into intimate contact with the hair, etc., of the previous occupants of the kraal.

The " clean " goats were kept in the kraal from the 24th February to the 11th December, 1930, i.e. nearly 10 months.

5. *Digging up Manure.*—Many farmers firmly believe that the mange parasites can live for long periods in the manure in the kraal. They maintain that if the manure is dug up the parasites will be brought to the surface and a fresh infection of mange may be expected.

In order to test the validity of this contention the manure in our kraal was dug up twice during the period that the clean goats occupied the kraal.

6. *Result of Test.*—The tested goats were examined regularly during the ten months that they occupied the " infected " kraal, but never was a sign of infection found on them.

Figures 7 and 8 show these goats in the kraal during the course of the experiment. Their healthy, contented appearance is in marked contrast with the emaciated and restless appearance of the three infected goats which had been discharged on the 7th February (see Fig. 9). It should be added that one of these three goats died from mange on the 27th April, 1930.

The six test goats were again thoroughly examined and discharged from the kraal on the 11th December, 1930. They were kept under further observation in another camp and remained absolutely free of mange. Figure 10 shows two of these goats photographed in November, 1931, i.e. 21 months after the commencement of the test, when they were still completely free of mange parasites.

Summary and Conclusions.

1. An experiment is described which was undertaken to find out whether a kraal which had harboured goats infected with *Sarcoptes scabiei caprae* would remain infective for a period of 17 days after removal of the infected animals.

2. Five badly infected Angora goats were kept in a small stone kraal for about 4½ months.

3. Two goats died in the kraal during this period.

4. Before removal the other three were shorn and the hair left in the kraal.

5. The kraal was then left empty for seventeen days.

6. Six clean Angora goats were then placed in the kraal and left there for about 10 months.

7. During this period the manure, which had never been removed from the kraal, was dug up twice.

8. The goats were examined regularly but remained absolutely free of infection.

9. Twenty-one months after the commencement of the test these goats were still perfectly healthy.

10. The conclusion seems justified that *a kraal which harboured mangy goats, if left empty for seventeen days, will no longer be able to infect clean goats.*

Fig. 1.—Angora goat infected with *Sarcoptes scabiei caprae.*

Fig. 2.—Angora goat infected with *Sarcoptes scabiei caprae.*

Fig. 3.—Angora goat infected with *Sarcoptes scabiei caprae.*

Fig. 4.—Infected goats in the kraal. The goat on the extreme right is *in extremis.*

Fig. 5.—Matting of hair on the floor of the kraal. Note also the hair clinging to the stones at the back.

Fig. 6.—The kraal just after the goats had been shorn and removed.

Fig 7.—The clean goats in the kraal.

Fig. 8.—The clean goats in the kraal.

Fig. 9.—The infected goats after removal to another camp.

Fig. 10.—Two of the clean goats photographed in November, 1931, about 21 months after the commencement of the test.

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

Wild Antelopes as Carriers of Nematode Parasites of Domestic Ruminants—Part II.

By H. O. MÖNNIG, B.A., Dr. Phil., B.V.Sc., Veterinary Research Officer, Onderstepoort.

In Part I of this series several worms of the Blesbuck (*Damaliscus albifrons*) were dealt with, and it was reported that the attempted transmission of *Impalaia nudicollis* and *Bigalkea albifrontis* to sheep had been unsuccessful. Further work with blesbuck has since been done and will be dealt with first.

1. BLESBUCK (*DAMALISCUS ALBIFRONS*).

Three young male blesbuck were kindly presented to this Institute by the Provincial Administration of the Orange Free State in May, 1931. They had been captured at Theunissen, O.F.S., and transported direct to Onderstepoort.

Faeces cultures of these buck showed larvae of *Strongyloides papillosus*, *Impalaia nudicollis*, *Haemonchus contortus*, *Trichostrongylus falculatus*, *Trichostrongylus* sp. rare, larvae which were later found to be those of *Bigalkea albifrontis* and larvae of a lungworm described below as *Bronchonema magna*. All three buck had moderately strong infections but the incidence of the different species in the three animals was not the same and this especially allowed the identification of the larvae of *B. albifrontis*.

From the faeces cultures of each buck one lamb was infected and after three weeks the following larvae were found in faeces cultures made from them: *H. contortus*, *T. falculatus*, *I. nudicollis* and *B. albifrontis*. The lambs were killed four weeks after infection and these four species were recovered from them, more or less in proportion to the number of larvae of each originally present in the faeces cultures of the respective blesbuck.

B. albifrontis and *I. nudicollis* were found in all three lambs, the former in large numbers in one lamb and the latter only in small numbers in all three cases. The receptivity of sheep for these worms has thus been proved, although it seems as if *I. nudicollis* does not readily adapt itself to this host. The lungworm *B. magna* was not found in these lambs.

On the 9th July, 1931, one of the blesbuck died of haemolysis due to an injection of blood made in connection with other investigations. This buck at post-mortem was found to harbour the following worms: *Bronchonema magna*, *H. contortus*, *I. nudicollis*, *B. albifrontis*, *T. falculatus* and, in the abomasum, a small number of worms described below as *Trichostrongylus minor*.

Further attempts were then made to transmit *Bronchonema magna* and *Trichostrongylus minor* to lambs. Two lambs were given each a fair number of infective larvae of *B. magna* and killed a few weeks later with negative result. These lambs also received other larvae from the buck but, since *T. minor* was apparently present in very small numbers only, it was not found in the lambs. *Bigalkea albifrontis* was again transmitted in these two cases.

Meanwhile the two remaining blesbuck were given larvae of *Oesophagostomum columbianum*, *Ostertagia circumcincta* and *O. trifurcata*. Larvae of *Ostertagia* were found in faeces cultures after four weeks and *O. columbianum* after six weeks in both blesbuck. It is not possible, with our present knowledge, to distinguish between the larvae of the two species of *Ostertagia*.

One of these blesbuck died on the 10th October, 1931, and at post-mortem the following worms were recovered from it:—*Bronchonema magna* in the lungs, *Haemonchus contortus*, *Bigalkea albifrontis*, *Ostertagia circumcincta*, *O. trifurcata*, *Trichostrongylus axei*, *T. falculatus* and *T. minor* in the abomasum, *Impalaia nudicollis* in the small intestine and *Oesophagostomum columbianum* in the colon. The latter were undersized and the females contained no eggs.

The other blesbuck died on the 5th December, 1931, and the following worms were recovered from it: *Bronchonema magna* in the lungs, *Haemonchus contortus*, *Bigalkea albifrontis*, *Ostertagia circumcincta* and *Trichostrongylus axei* in the abomasum, *Impalaia nudicollis*, *Trichostrongylus minor* (1 male), *Cooperia punctata* and *C. pectinata* in the small intestine, *Trichuris ovis* (1 male) and *Oesophagostomum columbianum* in the caecum and colon. The two species of *Cooperia* had apparently been acquired naturally from three infected calves which had been in the same pen for a few weeks. The specimens of *Oes. columbianum* were fairly numerous but, as in the previous case, smaller than normal, even females which contained eggs. Of the latter the five largest ones measured 12·5-14·5 mm. in length. Ten females taken at random from a lot of *O. columbianum* originating from sheep were found to measure 17·8-21·8 mm. in length. It may be noted here that Ransom (1911) gives the length of the female worm as 14-18 mm., a statement which is apparently taken over by Baylis (1929) from Ransom, but this measurement is undoubtedly too small.

It seems then to be the case that the blesbuck is not a very suitable host for this worm, although the latter grows to maturity and reproduces in it (larvae were found in faeces cultures of these buck

continually from about 6 weeks after infection until the hosts died). It has previously been noted, see Sarles (1929), that *Ancylostoma braziliense* grows to a larger size in dogs than in cats, a somewhat parallel case.

BRONCHONEMA MAGNA N. GEN., N. SP.

These are large white worms, with the intestine showing as a narrow brown streak. They are located in the smaller bronchi, where they lie in a thick mucus secretion occluding the passage, as is the case with *Dictyocaulus filaria* in sheep.

The mouth is surrounded by two lateral lips which have slightly wavy edges; there is no sign of dorsal and ventral lips (Figs. 1 and 2). The cuticle surrounding the head is slightly inflated, especially on the dorsal and the ventral sides. There are four small submedian head papillae.

There is no buccal capsule as in *Dictyocaulus*, the oesophagus begins immediately behind the mouth opening and is simple except for a slight swelling at the anterior extremity. It is 1·13-1·24 mm. long in the males and 1·61-1·68 mm. in the females.

The excretory pore is situated 0·52 mm. from the anterior end in the males and 0·79 mm. in the females and opens into a large excretory vesicle, which presses the oesophagus aside in that region. Cervical papillae were not seen. The nerve ring lies 0·38-0·42 mm. from the anterior end in the males and 0·59-0·64 mm. in the females.

The *males* are 44-60 mm. long and 0·29 mm. thick. The head, including the cuticular swelling, is 0·113 mm. wide. The bursa is 0·44 mm. long and has large lateral and a small dorsal lobe (Fig. 3). The rays are very similar to those of *D. filaria*. The antero-lateral stands apart from the medio- and postero-laterals which are fused together except at the tips. The externo-dorsal arises separately from the dorsal and the latter has no stem but two branches arising separately, each bearing two small, knob-like side-branches behind its middle.

The spicules are two long, stout, dark brown structures, conspicuous already in the live worm. They are 2·05-2·38 mm. long and 0·053 mm. thick, bearing a single alar expansion which also surrounds the blunt distal end. The gubernaculum is oval anteriorly with a posterior, broadly pointed extremity; it is 0·18-0·2 mm. long and pigmented brown (Fig. 3).

The *females* are 109-128 mm. long and 0·59 mm. thick. The head is 0·15 mm. wide. The hind end tapers off gradually to a thin tail which is 0·55-0·6 mm. long (Fig. 4). The vulva is inconspicuous, situated 50-53 mm. from the hind end in worms 123-128 mm. long. It opens into a capacious vagina 0·59 mm. long, which is connected anteriorly and posteriorly to short, wide ovejectors, each 0·5 mm. long. From the latter arise the ovaries, their exit into the ovejectors being apparently closed by sphincters (Fig. 5). The female genital organs are of the amphidelph type. Eggs with thin shells, measure 0·135-0·154 mm. by 0·064-0·082 mm. Ovoviviparous.

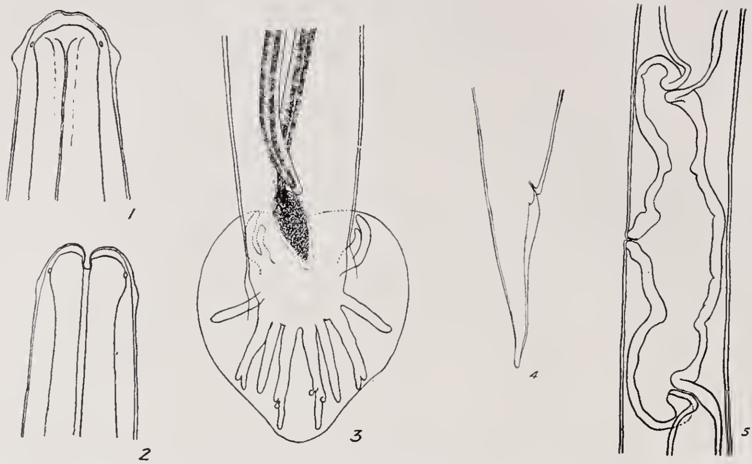


Fig. 1.—*Bronchonema magna.* Head, lateral view.
Fig. 2.—*Bronchonema magna.* Head, dorsal view.
Fig. 3.—*Bronchonema magna.* Hind end of male.
Fig. 4.—*Bronchonema magna.* Hind end of female.
Fig. 5.—*Bronchonema magna.* Female, distal part of genital organs.

Host.—Blesbuck (*Damaliscus albifrons*).

Location.—Bronchi.

Locality.—Onderstepoort, recently from Theunissen, O.F.S.

Types in Onderstepoort Helminthological Collection No. 2346.

This worm closely resembles the members of the genus *Dictyocaulus* in many respects, as is evident from the above description and also in its life history, described below. It differs, however, in a few points which must be considered important, viz. two lips, the absence of a buccal capsule and the very large spicules, while *Dictyocaulus* is characterized by the presence of four lips, a small buccal capsule and very short spicules. It was considered that these differences warrant the erection of a separate genus and that this would be preferable to making important alterations to the generic diagnosis of *Dictyocaulus*.

Generic diagnosis—Bronchonema.—Metastrongylidae with two lateral lips and without a buccal capsule. Male: bursa well developed, ventral rays cleft, antero-lateral separated from other laterals, medio- and postero-lateral fused except at their tips, externo-dorsals arise independently, dorsal ray double and each bears two small side-branches; spicules equal, long and thick; gubernaculum present. Female: vulva near the middle of the body; amphidelph; ovoviviparous. Parasites in the bronchi of ruminants.

Development of Bronchonema Magna.

The free-living stages of the parasite were studied in order to determine whether an intermediate host is required or not. The eggs hatch during their passage through the digestive tract of the

host and the first stage larva is found in the fresh droppings. When a number of fresh faecal pellets are placed in a small quantity of tapwater in a petri dish, the larvae very soon enter the water and can be picked out, as they swim about actively. These larvae are more active than the first stage larvae of *D. filaria*, but the diagnosis of lungworm infection in the latter case can also be made in the same way. The first stage larva (Figs. 6, 7 and 8) has the following measurements :—

Tail: 0·071-0·078 mm.
Genital cell: 0·28-0·3 mm.
Excretory pore: 0·101-0·109 mm.
Nerve ring: 0·09 mm.
Oesophagus: 0·12-0·14 mm.
Breadth: 0·024 mm.
Length: 0·55-0·59 mm.

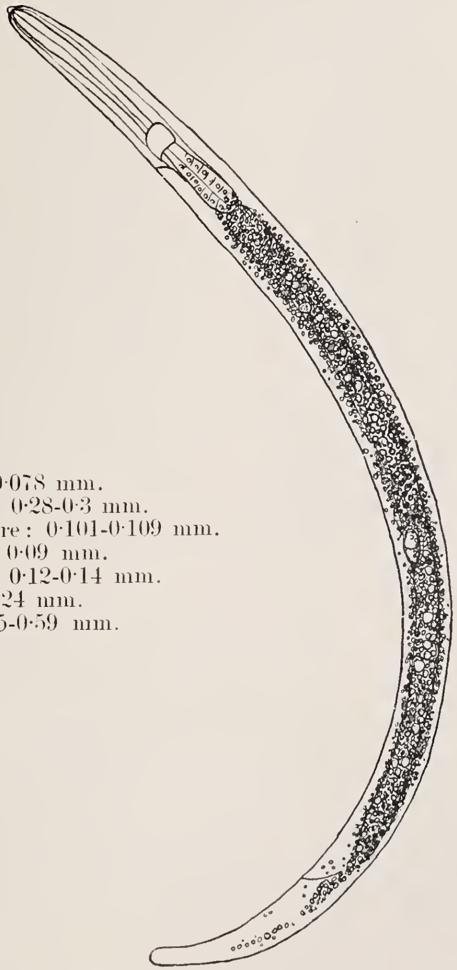


Fig. 6

Fig. 6.—*Bronchonema magna.* First stage larva.

The cephalic cuticle bears a knob-like thickening anteriorly, as is seen in the larva of *D. filaria*. There are four submedian head papillae and the cuticle bears fine transverse striations except on the posterior fifth of the tail. The oesophagus is constricted in the middle third of its length but is not rhabditiform. The intestinal cells are so full of dark granules that their boundaries and their number cannot be made out. The anus and the rectum are very indistinct and are invisible in most specimens. The tail is relatively long and has a blunt, slightly thickened extremity.

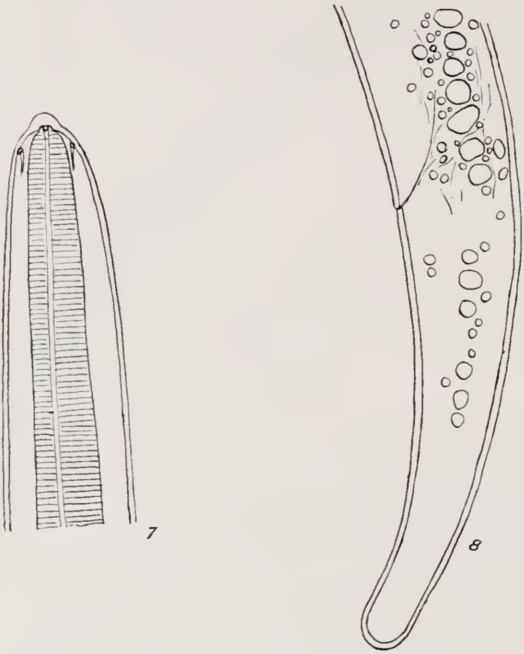


Fig. 7.—*Bronchonema magna.* First stage larva, head end.
Fig. 8.—*Bronchonema magna.* First stage larva, tail end.

The larvae were kept in petri dishes containing tapwater or an infusion of sterilized sheep faeces, at a temperature of about 25° C. After 27 hours, from the time the faeces had been taken from the rectum of the host, the first signs of an ecdysis were seen. After 31 hours most of the larvae were in the second stage, but were still enclosed in the cuticle of the first stage. The head (Fig. 9), is now somewhat flattened anteriorly, with a thick cuticle. The tail still ends with a knob-like thickening. The larvae in the second stage have the following measurements:—

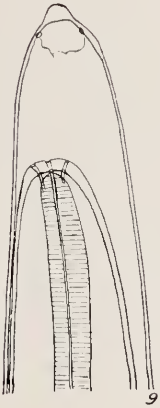
Length (total): 0·59-0·63 mm.

Excretory pore: 0·115 mm.

Oesophagus: 0·13-0·142 mm.

Genital cell: 0·365 mm.

The larvae remain fairly active most of the time, but become quiescent for a short period before each ecdysis. After 50 hours the first larvae loosened the second skin and thus passed into the third stage. They retain both sheaths for a few hours only, then cast off the outer one. Fig. 10 shows the tail end of a larva in both sheaths. The third stage larvae have the following measurements:—



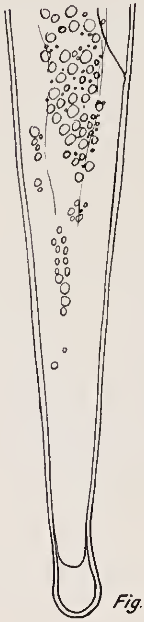


Fig. 9.—*Bronchonema magna.* Second stage larva, anterior end.
Fig. 10.—*Bronchonema magna.* Third stage larva in two sheaths, tail end.
Fig. 11.—*Bronchonema magna.* Hind end of third stage larva.

Length (total): 0·59-0·64 mm.
Oesophagus: 0·157-0·161 mm.
Nerve ring: 0·09-0·105 mm.
Excretory pore: 0·105-0·120 mm.
Genital cell: 0·345-0·394 mm.
Tail of larva: 0·071 mm.
Tail of sheath: 0·082 mm.

The head of the third stage larva is bluntly rounded and carries four submedian papillae, as in the previous stages. The shape of the oesophagus has not changed. The tail ends in a blunt point and is surrounded by the sheath, which forms behind the larval tail a very characteristic loop (Fig. 11).

Bionomics of the Third Stage Larva.

The infective larvae are fairly active but do not migrate upwards from faeces cultures as well as Trichostrongyle larvae, although a few were found on the walls of the culture jars.

The larvae revived on moistening after having been dry on slides for 17 hours but not after longer periods. The conditions of the test were rather severe, as the slides were kept in a heated room with dry atmosphere. However, *Trichostrongylus* and *Haemonchus* larvae, placed on the same slides as controls, still revived after 60 hours when the test was stopped. *Bronchonema magna* larvae can therefore apparently resist drying for a short period only.

Third stage larvae were kept in tap-water about 2 mm. deep and remained alive for 53 days. At the end of this period the granules in the intestinal cells had disappeared and the larvae apparently reached the limit of their resources.

From the above it would seem that the life-history is direct and does not need an intermediate host, if one may compare this species to *Dictyocaulus filaria*, of which the life history is a perfect parallel.

TRICHOSTRONGYLUS MINOR n. sp.

Small, delicate worms, in appearance much like *T. axei*. The *males* are 4·3-5·67 mm. long and 0·071 mm. thick. The oesophagus is simple, 0·71-0·79 mm. long, surrounded by the nerve ring 0·13-0·138 mm. from the anterior extremity. The excretory pore opens 0·169-0·175 mm. from the anterior end.

There is a well developed bursa with rays typical of the genus (Fig. 12); the antero-lateral is the thickest of the rays; the latero-ventral is widely separated from the ventro-ventral and curves sharply to the ventral side near its distal end, the medio-lateral curves to the dorsal side distally; the externo-dorsal ends a short distance from the bursal margin; the dorsal ray bifurcates distally, each branch being bidigitate (Fig. 13).


12


13

Fig. 12.—*Trichostrongylus minor* n. sp. Male, bursa, lateral view.
Fig. 13.—*Trichostrongylus minor* n. sp. Male, bursa, dorsal rays.

The spicules are subequal or equal, 0·1-0·108 mm. long and almost similar in appearance. They are, as is usual in many Trichostrongyles, longitudinally folded (Fig. 14), distally tapering to a sharp point and bearing posteriorly a pointed or rod-shaped projection from each of the two edges of the folded body; these projections support the large cuticular alae at the distal end of the spicule. The gubernaculum (Fig. 15) is 0·053 mm. long and of the same type as seen in *T. axei*.

The *females* are 5·2-5·57 mm. long and 0·078 mm. thick. The oesophagus is 0·69-0·77 mm. long. The nerve ring and the excretory pore are situated respectively 0·13-0·138 mm. and 0·169-0·175 mm. from the anterior end. The tail (Fig. 16) is 0·074-0·082 mm. long and pointed. The vulva is a longitudinal, crescent-shaped slit; the left border forms a small flap overhanging the opening (Fig. 17).

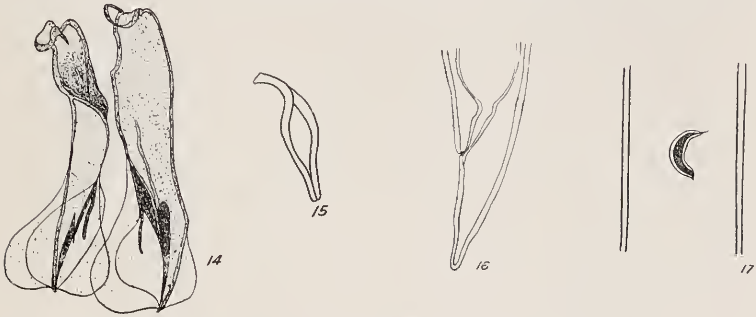


Fig. 14.—*Trichostrongylus minor* n. sp. Male spicules.
Fig. 15.—*Trichostrongylus minor* n. sp. Male gubernaculum.
Fig. 16.—*Trichostrongylus minor* n. sp. Female, tail.
Fig. 17.—*Trichostrongylus minor* n. sp. Female, vulva.

It is situated 0·96 mm. from the hind end. The genital organs are of the usual type as found in this genus. The ovejectors are each 0·206-0·224 mm. long. Eggs measure 0·82-0·90 × 0·41-0·45 mm.

Host.—Blesbuck (*Damaliscus albifrons*).

Location.—Abomasum.

Locality.—Onderstepoort, recently from Theunissen, O.F.S.

Types in Onderstepoort Helminthological Collection No. 2347.

Infective Larvae of *BIGALKEA ALBIFRONTIS*.

The infective larvae of this worm are very difficult to distinguish from *Cooperia* larvae (see Mönnig 1931b), having very much the same measurements except that the oesophagus is shorter. The following measurements were taken from larvae found in the faeces cultures made from the blesbuck:—

Length (total, including sheath): 0·64-0·75 mm.

Oesophagus: 0·131 mm.

Genital cell from anterior end: 0·319 mm.

Tail of larva: 0·056-0·068 mm.

Tail of sheath: 0·124 mm.

IMPALAIA NUDICOLLIS and *I. TUBERCULATA*.

Since these two species are very similar, it was considered advisable, to compare a larger selection of specimens of *I. nudicollis* with the co-types of *I. tuberculata* in the Onderstepoort collection and this was done when sufficient material from different sources had been obtained. The comparison showed that there are distinct differences, the chief being the larger bursa and dorsal ray in *I. tuberculata*

and the different lengths of the spicules. During this examination the specimens of *I. tuberculata* were transferred from glycerin through alcohol to lacto-phenol and it was then found that a small percentage had lost the tubercles on the anterior part of the body. It appears, therefore, that these structures were artefacts and not a normal part of the worm and that their presence is not a characteristic of this species.

2. SPRINGBUCK (*ANTIDORCAS MARSUPIALIS*).

Specimens of *Agriostomum equidentatum* and *Oesophagostomum columbianum* were forwarded by the Government Veterinary Officer stationed at Aliwal North, Cape Province, having been collected from springbuck in that district.

Further material was obtained from several springbuck sent to the Pretoria Zoo from Houtkraal, Cape Province. The following worms were found in both of two buck that died: *Nematodirus spathiger*, *Cooperia serrata*, *Trichostrongylus falculatus*, *Agriostomum equidentatum* and, in the abomasum, a worm described below as *Ostertagia hamata* n. sp.

Larvae from faeces cultures of these buck were given to two lambs and the latter were killed 3 weeks after infection, harbouring *Trichostrongylus falculatus*, *Cooperia serrata* and a fair number of adult *Ostertagia hamata* in both cases. The latter worm must therefore be added to the list of nematodes transmitted to sheep.

OSTERTAGIA HAMATA N. SP.

Slender worms, of a deep brown colour when fresh. The mouth appears to be surrounded by six small lips and opens into a small buccal capsule. The cervical papillae are thorn-like, broad at the base, situated 0·33-0·42 mm. from the anterior extremity. The cuticle of the head is not inflated but there is a slightly dilated portion corresponding to a mouth collar which is 0·022-0·028 mm. wide. The cuticle on the body bears the usual longitudinal striations, about 26 at the posterior end of the oesophagus and up to 35 farther back.

The oesophagus which is 0·71-0·8 mm. long in the males and 0·71-0·86 mm. in the females, increases gradually in diameter backwards and is surrounded by the nerve ring 0·24-0·29 mm. from the anterior end of the body. The excretory pore lies in a slight depression of the body-wall just anterior to the level of the cervical papillae.

The *males* are 6·6-7·85 mm. long and 0·09-0·11 mm. broad in front of the bursa. The latter has large lateral lobes, a small dorsal lobe and an accessory bursal membrane. Prebursal papillae are present. The ventral rays (Fig. 18) are close together except for a slight backward bend of the latero-ventral in its second half; their tips come close to the margin of the bursa which shows a distinct identation at this point. The antero- and medio-lateral rays are close together and distally bend forward, while the postero-lateral diverges widely backwards in its distal half. The externo-dorsal arises from the base of the dorsal stem and it also receives an equally thick band of muscular tissue from the direction of the lateral rays, so that its base is very wide. The dosal ray is short and bifurcates distally into two short, stout branches which both end in two thick digitations.

The spicules are pigmented brown and are equal and similar in structure, 0·161-0·191 mm. long. Each spicule (Fig. 19) has a main body which ends in a broad tip, bent towards the medial aspect at its extremity and surrounded by a hyaline portion; this body is hollow medially and bears on its ventral edge a short spur while the dorsal edge gives rise to a longer spur with a flattened and somewhat twisted end resembling a hook, especially in a lateral view. This structure of the spicule is very characteristic and is responsible for the name of the species. Both the spurs, as well as the main body of the spicule, bear cuticular alae which are well visible only in spicules that have been removed from the body of the worm. A gubernaculum is present and has the usual shape as found in this genus, running out into a slender point posteriorly which appears to be fixed to the cloacal opening; it is about 0·112 mm. long.

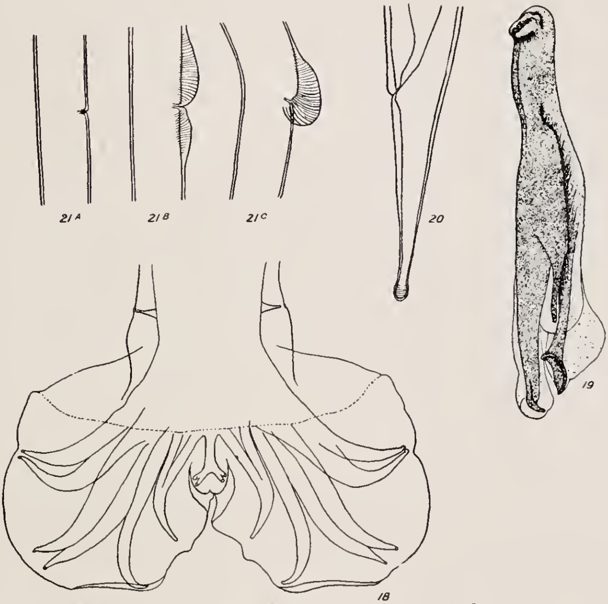


Fig. 18.—*Cooperia hamata* n. sp. Male, bursa extended.
Fig. 19.—*Cooperia hamata* n. sp. Male, ventral view of right spicule.
Fig. 20.—*Cooperia hamata* n. sp. Female, tail.
Fig. 21.—*Cooperia hamata* n. sp. Female, variations in cuticle around vulva.

The *females* are 8·09-11·02 mm. long and 0·116 mm. broad in the region of the vulva. The tail is gradually attenuated to a slightly swollen tip (Fig. 20) which bears faint transverse striations as are seen in the females of *O. circumcincta*; it measures 0·176-0·19 mm. in length. The vulva is situated 1·34-1·76 mm. from the posterior extremity. In some specimens it is an inconspicuous longitudinal slit, in others the cuticle anteriorly and posteriorly to the opening is inflated and transversely striated and a series of forms can be found leading up to the stage of a fairly strong anterior flap overhanging the vulva (Fig. 21). The vagina is 0·28-0·34 mm. long

and the ovejectors are each 0·15-0·23 mm. long, the anterior half of the vagina and the anterior ovejector are in most specimens longer than the corresponding posterior parts. The eggs are segmenting when laid and measure 0·071 × 0·039 mm.

Host.—Springbuck (*Antidorcas marsupialis*). The specimens obtained from this host were slightly decomposed and the description of the female has been supplemented by studying material obtained from sheep. The drawings of the female (Figs. 20 and 21) have been made from the latter material.

Location.—Abomasum.

Locality.—Pretoria Zoo, recently from Houtkraal, Cape Province.

Types in Onderstepoort Helminthological Collection No. 2366.

3. RHEBUCK (*PELEA CAPREOLUS*).

The following nematodes were collected from rhebuck shot in Swaziland in July, 1931:—

Oesophagostumum columbianum in one animal.

Haemonchus bedfordi in one animal.

Ostertagia circumcincta in three animals.

The latter two parasites are recorded here for the first time from this host.

4. STEENBUCK (*RHAPHICEROS CAMPESTRIS*).

From this host, shot in Swaziland, two species of *Skrjabinema* were collected in the large intestine, the one being identical with *S. ovis* and the other is a new species described below as *S. africana*, n. sp.

SKRJABINEMA OVIS (Skrjabin, 1915) Wereschtschagin, 1926.

The history of our knowledge of this species has been fully dealt with recently by Morgan (1930) and by Böhm and Gebauer (1930). Its morphology has been the subject of careful studies by Schwartz (1927) and Morgan (1930) besides the original Russian authors. The publication of Schwartz was unfortunately not available to the present writer.

The material from the steenbuck consists of one male and five females and corresponds closely with the descriptions of *S. ovis*. The tail of the male, however, appears not to have been quite correctly described. The caudal alae are supported by two pairs of large papillae, one preanal and one postanal. Wereschtschagin states that these papillae have each three terminal conical processes in the nature of a crown; he draws these three processes and in addition two small papillae. Morgan states that there are three small papillae at the tips. This seems to be due to an optical illusion. There is a single terminal papilla surrounded by a slightly thickened rim of cuticle (Fig. 22); when the microscope is not sharply focussed the edges of this rim present the appearance of another two papillae.

Immediately behind the cloacal opening there are two lateral swellings, each bearing three minute papillae as described by previous authors. Behind these one finds the openings of the caudal glands, at the bases of the large postanal papillae. Morgan does not mention these pores but Wereschtschagin describes them as pedunculate papillae.

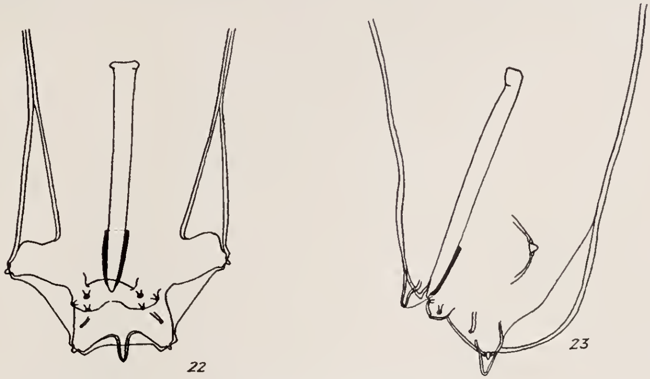


Fig. 22.—*Skrjabinema ovis.* Male, tail, ventral view.
Fig. 23.—*Skrjabinema ovis.* Male, tail, lateral view.

The anterior lip of the cloaca is raised into a prominent transverse fold which, in a lateral view (Fig. 23) appears like what Morgan describes as " a spike terminating the tail in the mid-ventral line ". The lateral angles of this fold have apparently misled Wereschtschagin to describe them as a pair of papillae, although in lateral views he figures a spike-like structure close to the ventral line. The terminal, acute point of the tail is mentioned by all the authors.

The distribution of *S. ovis* as known at present is as follows:—

Sheep: Turkestan.

Goat: Turkestan, Austria, United States, England.

Gazella subgutturosa: Turkestan.

Rhaphiceros campestris: South Africa.

SKRJABINEMA AFRICANA, n. sp.

The material consists of only three females, which are still immature. They appear to be closely related to *S. rupicaprae* Böhm and Gebauer, 1930, having the same characteristically hidden lips, which are very similar to those of *S. alata* from the sheep, described below. While the lateral flanges of the lips of *S. rupicaprae* are described as narrow projections, they end in wide expansions in *S. africana* and *S. alata*. The heads of the latter two species are morphologically very much alike and the description of the head, to be given for *S. alata*, applies in general also to *S. africana*.

The measurements of *S. africana* are given in the table below. This species differs from *S. rupicaprae* in the above-mentioned structure of the lips and the following points: The worms, although immature, are slightly longer than *S. rupicaprae*, while their

greatest breadth is less than in that species. The head again is broader. The excretory pore is situated farther back. The oesophageal bulb, which in *S. rupicaprae* is stated to be noticeably longer than broad (a proportion of 1·144 to 1), appears to be almost spherical in *S. alata* (the measurements give a proportion of 1·108 to 1). These differences, coupled with the differences as regards hosts and localities, amply justify the creation of a new species for this parasite of the steenbuck.

Host.—*Rhaphiceros campestris.*

Location.—Large intestine.

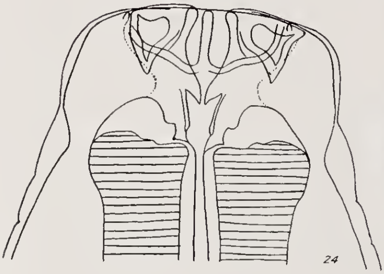
Locality.—Swaziland, South Africa.

Types in Onderstepoort Helminthological Collection No. 2402.

SKRJABINEMA ALATA, N. SP.

In conjunction with the above described material of *Skrjabinema* a study was made on seven females of a worm that had been provisionally labelled *Skrjabinema* and placed in the Collection under No. 2298. This material was found by the writer towards the end of 1927 in the helminthological section of this Institute in a bottle labelled " Colon of Sheep " and in another handwriting " Young *Oesophagostomum columbianum* "; it had apparently been forwarded by a farmer or a veterinary officer from some part of the Union.

The measurements of these worms are given in the table below. The head is slightly constricted off from the body and the lips are sunken into an anterior depression (Fig. 24) or, as Böhm and Gebauer (1930) state in the case of *S. rupicaprae*, the mouth opening is surrounded by a " mouth-wall ". The rim of this depression bears two large lateral and four smaller submedian papillae (Fig. 25).



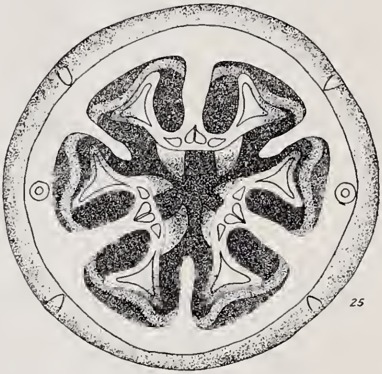


Fig. 24.—*Skrjabinema alata* n. sp. Head, lateral view.
Fig. 25.—*Skrjabinema alata* n. sp. Head, anterior view.

There are a dorsal and two subventral lips, equal in size and three narrow, intermediate lips. Each lip consists of a narrow body, projecting from the " mouth-wall " into the cavity in the form of a partition. Anteriorly the free edge of this body bears on either side a flange, directed outwards and widening distally so that it

ends in two angles, one lying near the body of the lip and close to the rim of the mouth-wall, the other away from the body of the lip and dipping down into the cavity. The lip as seen from above therefore appears to be T-shaped with the arms bent back and slightly twisted. The free edge of the body bears at about its middle two tooth-like blades which project downwards. The bases of the main lips and the intermediate lips are connected by horizontal bars of chitin lying in the form of a ring around the inside of the " mouth-wall " (Fig. 25). In the base of the mouth cavity the cuticle, which covers the anterior extremity of the oesophagus, is much thickened and bears six small teeth, a pair on each sector of the oesophagus. The oesophagus has an anterior cylindrical portion and an almost spherical bulb. The anterior portion of the oesophagus is surrounded by six or more small cephalic glands, reaching back to a point about 0·128 mm. from the anterior end of the worm. The nerve ring surrounds the oesophagus a short distance behind these glands.

The cephalic swelling of the cuticle is not marked in this species but there are conspicuous lateral alae, more than twice as wide as in *S. africana*. These alae are transversely striated and arise at about the middle of the oesophageal region, ending at about the middle of the tail. In *S. africana* the alae end much nearer to the tip of the tail but this may be because the worms are immature.

The excretory pore is situated behind the oesophageal region but not as far back as in the immature specimens of *S. africana*. Also the vulva is not as far back as in that species. These two significant differences, as well as the greater size of *S. africana* and the smaller breadth of its lateral alae sufficiently prove that these worms belong to two different species.

The following points serve to distinguish *S. alata* from *S. rupicaprae*: greater width of head, the structure of the lips, more anterior positions of the excretory pore and the vulva, the greater length of the tail, the more spherical shape of the oesophageal bulb as well as the greater length of the oesophagus, although the worms themselves are about equally long.

It therefore seems to be clear that this material from the sheep represents a new species.

Host.—*Ovis aries.*

Location.—Colon.

Locality.—South Africa (very probably).

Types in Onderstepoort Helminthological Collection No. 2298.

	S. alata.	S. africana.	S. rupicaprae. (from Böhm and Gebauer)
Length	4·61–5·16	5·12–5·8	4·5–5·6
Breadth, vulvar region	0·31	0·29–0·38	0·36–0·40
Breadth, head	0·082	0·075	0·06–0·068
Excretory pore	0·824–0·915	1·28–1·37	1·0064–1·1424
Nerve ring	0·169	0·15–0·169	—
Oesophagus, total length	0·662	0·413–0·515	0·48–0·59
Bulb, length	0·150	0·154–0·165	0·120–0·150
Bulb, breadth	0·146–0·150	0·146–0·150	0·108–0·128
Vulva, from head end	1·24–1·5	1·88–2·1	1·75–2
Tail	0·95–1	0·55–0·59	0·56–0·68
Lateral alae, breadth at vulva	0·034	0·015	—
Lateral alae, end from posterior extremity	0·4–0·53	0·11–0·13	—
Eggs, length	0·052–0·058	immature	0·059–0·067
Eggs, breadth	0·030–0·032	—	0·032–0·040
Vagina, length	0·18–0·206	—	—
Vagina, breadth	0·067–0·094	—	—

(All measurements in millimetres.)

The Genus *SKRJABINEMA*.

In this genus we now have the following species:—

S. ovis, hosts and distribution given above.

S. tarandi, from *Rangifer tarandus*, Northern Russia.

S. rupicaprae, from *Rupicapra rupicapra*, Austria.

S. africana, from *Rhaphiceros campestris*, South Africa.

S. alata, from *Ovis aries*, South Africa.

The first two species (*ovis* and *tarandi*) differ considerably from the last three (*rupicaprae*, *africana* and *alata*) in the structure of the head. Their lips project forwards and the buccal cavity lies chiefly behind them, while in the last three species the lips are fixed inside the wall of the buccal cavity. It was at first thought, on account of the general similarity of the lips in the two groups, that they had been drawn into the cavity in the latter group, as the lips can be drawn in, e.g. in *Crossocephalus*. However, it could be expected in such a case that there would be variations in the degree of invagination in a number of specimens. We now know 3 males and 15 females of *S. rupicaprae*, 3 females of *S. africana* and 7 females of *S. alata*, a total of 28 specimens, all showing the same position of the lips. Moreover the structure of these organs leaves no doubt that they are fixed in this position.

Unfortunately the males of *S. africana* and *S. alata* are still unknown, but it is possible that in the male tails further points of differentiation between the two groups could be found.

The general structure of the body, including the lips and male tails (*S. ovis* and *S. rupicaprae*) is, however, similar and it is evident that the genus *Skrjabinema* represents a natural group on a par with

other genera of the *Oxyuridae*. For these reasons it would be undesirable to split up the genus into two genera, but at the same time two subgroups stand out very clearly and it is therefore proposed to create two subgenera for these groups as follows:—

Genus *Skrjabinema*—*Oxyuridae* of small size. Cuticle inflated around the anterior end of the body and provided with lateral alae for the greater part of the body length. Two lateral and four submedian head papillae present. Mouth opening surrounded by three T-shaped lips, each bearing a pair of tooth-like plates projecting towards the centre of the opening. Intermediate lips present. Excretory pore behind level of oesophagus. Tail of male with small lateral alae supported by two pairs of large papillae, one preanal and the other postanal; the tail further bears a number of small papillae and ends in an accute point. A single, spicule and a gubernaculum are present. Vulva in anterior half of body. Parasites of ruminants.

Subgenus *Skrjabinema*—*Skrjabinema*: Lips not surrounded by wall of mouth capsule and project forwards. Species *S.* (*S*). *ovis*, *S.* (*S*). *tarandi*.

Subgenus *Chilocrypta*—*Skrjabinema*: Lips surrounded by wall of mouth capsule and project towards centre of mouth opening. Species *S.* (*C*). *rupicaprae*, *S.* (*C*). *africana* and *S.* (*C*). *alata*.

5. SASSABY (*DAMALISCUS LUNATUS*).

The following worms were collected from this host by Dr. H. H. Curson of this Institute in Ngamiland (Northern Bechuanaland), and all are new records for the Sassaby:—In the abomasum *Haemonchus contortus* and *H. bedfordi*. In the small intestine: *Impalaia nudicollis*, *Agriostomum cursoni* Mönnig, 1932, *Cooperia fuelleborni* and *Cooperia hungi* n. sp.

COOPERIA HUNGI n. sp.

Syn. *Cooperia fuelleborni hungi* Mönnig, 1931.

In Part 1 of this series the writer recorded the finding of a few specimens of this worm in a Waterbuck (*Cobus ellipsiprymnus*) and its successful transmission to sheep. The specimens available were few in number, and since they were mixed with specimens of *C. fuelleborni* it was not found possible to separate the females. On account of the general resemblance of these worms *C. hungi* was named as a variety of *C. fuelleborni*.

In the material obtained from the Sassaby the latter species was represented by a few specimens only, while *C. hungi* was more numerous and distinct differences between the females could be found, so that it now appears desirable to raise the name to the rank of a species.

The worms are typical *Cooperias* with a small inflation of the cuticle in the cephalic region and longitudinal striations on the rest of the body. The male has been briefly described in the paper cited above, and its spicules have also been illustrated. Measurements are given in the table below.

The female is characterized by a distinct swelling of the body in the vulvar region (Fig. 26), especially on the dorsal and lateral aspects. The tail (Fig. 27) narrows suddenly behind the anus and has an acute point. A pair of lateral caudal papillae is situated a short distance behind the middle of the tail.

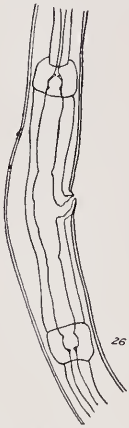


Fig. 26.—*Cooperia hungi* n. sp. Female, vulvar region.
Fig. 27.—*Cooperia hungi* n. sp. Female, tail.

	Male.	Female.
	mm.	mm.
Body length	7·6–9·1	10·5–10·7
Breadth	0·116	0·157
Diameter of head	0·045	0·048–0·05
Oesophagus length	0·44–0·46	0·46–0·48
Anterior end to nerve ring	0·238–0·27	0·29
Anterior end to excretory pore	0·238–0·27	0·29
Posterior extremity to vulva	—	2·6–2·9
Length of tail	—	0·176–0·195
Length of each ovejector	—	0·37–0·42
Length of spicules	0·225–0·235	—
Eggs	—	0·068 × 0·049

LIST OF NEW HOST AND PARASITE RECORDS IN THIS PAPER.

ANTIDORCAS MARSUPIALIS (Springbuck).

Ostertagia hamata n. sp.

DAMALISCUS ALBIFRONS (Blesbuck).

Bronchonema magna, n. gen., n. sp.
Cooperia pectinata.
Cooperia punctata.
Oesophagostomum columbianum.
Ostertagia circumcincta.
Ostertagia trifurcata.
Trichostrongylus axei.
Trichostrongylus falculatus.
Trichostrongylus minor n. sp.
Trichuris ovis.

DAMALISCUS LUNATUS (Sassaby).

Agriostomum cursoni.	*Haemonchus bedfordi.*
Cooperia fuelleborni.	*Haemonchus contortus.*
Cooperia hungi n. sp.	*Impalaia nudicollis.*

OVIS ARIES (Sheep).

Bigalkea albifrontis.	*Ostertagia hamata* n. sp.
Impalaia nudicollis.	*Skrjabinema alata* n.p.

PELEA CAPREOLUS (Rhebuck).

Haemonchus bedfordi.	*Ostertagia circumcincta.*

RHAPHICEROS CAMPESTRIS (Steenbuck).

Skrjabinema africana n. sp.	*Skrjabinema ovis.*

SUMMARY.

Description of one new genus *Bronchonema* (*Metastrongylidae*), type *B. magna* n. sp., from *Damaliscus albifrons* and five other new species, viz. *Trichostrongylus minor* from *Damaliscus albifrons*, *Cooperia hungi* (Syn. *C. fuelleborni hungi* Mönnig, 1931) and *Ostertagia hamata* from *Antidorcas marsupialis* and *Ovis aries*, *Skrjabinema alata* from *Ovis aries* and *Skrjabinema africana* from *Rhaphiceros campestris*. The genus *Skrjabinema* is divided into two subgenera, *Skrjabinema* and *Chilocrypta*. Experimental attempts at transmission of these and other worms from antelopes to sheep and vice versa are recorded. The free-living stages in the life history of *Bronchonema magna* are described and additions are made to the descriptions of some other nematode parasites of ruminants. A list of new hosts and new parasites is given.

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18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

Syngamus indicus: A New Nematode from the Indian Elephant.

By H. O. MÖNNIG, B.A., Dr.Phil., B.V.Sc., Veterinary Research Officer, Onderstepoort.

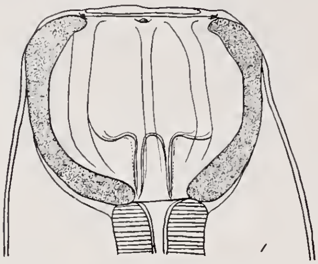
On the 19th January, 1931, a young circus elephant, that had been imported from India a few months previously, was autopsied at Onderstepoort. The elephant had been suffering from severe anaemia and, since this this was obviously due to worms, treatment had been attempted but the animal refused to swallow and eventually died of an intussusception of unknown origin, although its worm infection would also probably have terminated its life within a short time.

It was estimated at the autopsy, that the animal harboured fully 12 litres of worms, of which none are very large species. As far as the material has been studied, it can be said that there were two species of trematodes and at least ten species of nematodes belonging to nine different genera. The great majority of the nematodes were *Bathmostomum sangeri*.

In the posterior portion of the pharynx a male and a female *Syngamus* were found attached to the mucous membrane and, as usual in this genus, the pair were *in copula*. The worms are blood-red in colour when fresh. The body of the male gradually increased in thickness backwards and is constricted immediately anterior to the bursa. The body of the female also grows thicker up to a short distance behind the vulva, then gradually attenuates and is again thicker in the anal region. The male could be fairly easily separated from the female and it was found that the ventral part of the bursa was anterior in copulation.

There is practically no mouth collar and the cuticular striations are very indistinct and somewhat irregular, standing 0·026-0·045 mm. apart. The cervical papillae are short and thick, situated in the male 1·3 mm. from the anterior extremity and in the female 1·83 mm. The excretory pore is found 1·08 mm. from the anterior end in the male and 1·61 mm. in the female.

The mouth opening is surrounded by two lateral and four submedian papillae and opens into a strong buccal capsule which is 0·4 mm. deep and 0·44 mm. broad, including the walls, in both sexes. The wall bears internally six longitudinal ridges, two lateral and four submedian; such ridges have also been described in the case of *S. laryngeus* Railliet, 1899, and S. *hippopotami* Gedoelst, 1924. In the base of the buccal capsule there are eight teeth, 0·14 mm. high, all except the dorsal and the ventral standing against the longitudinal ridges (Fig. 1).



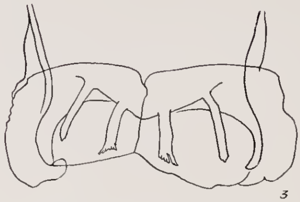


Fig. 1.—Anterior extremity, lateral view.
Fig. 3.—Male bursa, dorsal view.

The oesophagus, 1·34 mm. long in the male and 1·92 in the female, is club-shaped; its anterior half is narrow, 0·1 mm. in the male and 0·22 mm. in the female, and posteriorly it becomes thicker and reaches double the width of the anterior portion.

The nerve ring surrounds the narrow part of the oesophagus, 1 mm. from the anterior end of the body in the male and 1·28 mm. in the female.

The male is 8·5 mm. long and its greatest breadth is 0·59 mm. The bursa is very short but otherwise well developed and measures 0·49 mm. in a dorso-ventral direction. The ventral rays are thick, close together, and each ends with a narrow point (Fig. 2). The antero- and medio-lateral rays arise from a common stem and lie close together, while the postero-lateral arises separately, beginning with a narrow base, and diverges from the other laterals. The externo-dorsal rays arise quite independently (Fig. 3); they are the thinnest of the rays, rather short and end in narrow points like the ventrals. The two branches of the dorsal rays arise separately and their bases are quite a distance apart; they both end as if broken off with irregular, fringed extremities. Spicules could not be found and since there is only one male it was not considered advisable to dissect it.

The female is 30 mm. long and 0·91 mm. wide behind the vulva. The tail narrows down abruptly behind the anus and ends in a short point bent towards the ventral side. It is 0·338 mm. long. The vulva opens 9 mm. from the anterior extremity. The vagina is very short and gives rise to two thin-walled tubes which both run forwards but soon turn and widen to form the two uteri. The female genitalia

are for the rest mainly situated behind the vulva and reach a fair distance back, but each ovary has one short loop lying anterior to the level of the vulva. The eggs measure 0·094-0·105 by 0·049-0·056 mm. and their shells are thickened at the poles.

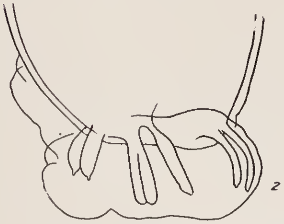


Fig. 2.—Male bursa, lateral view.
Fig. 4.—Hind end of female.

This worm has many features in common with *S. hippopotami*, but the rays of the male bursa differ as well as several measurements. On comparing it with other species of the genus, it is found that there is still less resemblance, and the name *Syngamus indicus* is therefore proposed for this parasite.

Host—Elephas indicus.

Location—Pharynx.

Locality—South Africa, recently imported from India.

Types in Onderstepoort Helminthological Collection No. 2372.

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On A New Species of *Tetrameres* (*Tetrameres paradisea* sp. nov.) from Stanley Cranes.*

By R. J. ORTLEPP, M.A., Ph.D., Research Officer, Onderstepoort.

THREE Stanley Cranes—*Tetrapteryx paradisea*—which had died in the Zoological Gardens at Pretoria, were forwarded to this Institute for examination. All were found to be parasitized by the nematode described below, and in addition one of the cranes harboured three female specimens of a helminth which the writer has tentatively identified as *Ascaridia stroma* (Linstow, 1899) R. & H., 1914. About two dozen females of the new parasite were obtained, these being lodged singly in the glands of Lieberkuhn. Their position was indicated by a rounded swelling on the outer side of the proventriculus and by a small red spot in the orifice of the gland; this spot was found to be the posterior extremity of the parasite which was sticking through the orifice of the gland; otherwise the internal surface of the proventriculus appeared quite normal. When gentle pressure was applied to each ot the swellings the worm was easily squeezed out of the gland. In addition to the females one male was obtained free in the mucus lying over the inner surface of the proventriculus; an intensive search of all this mucus together with scrapings from the proventriculus failed to provide any more males. The specimens collected were all fixed in hot 70 per cent. alcohol and after remaining in this fluid from 3 to 8 hours, all except one female, were transferred to lactophenol. These females, which had contracted considerably during fixation, began to swell out in the lactophenol, and unfortunately burst after they had been in this medium for over a day. All the details of the female internal organs were studied on this material. The remaining female was transferred to lactophenol after having been in the fixing fluid for two days; this specimen, after 24 hours, was also seen to have swollen, and was then again brought back to alcohol. The figure of the entire worm is a camera lucida drawing of this specimen.

The *females* are of a blood-red colour and prior to fixation have an oval outline; the fixed material is more rounded and is considerably smaller and broader than when fresh; fresh material is from 5 to 8.7 mm. long by 3 to 4 mm. broad, which is also the size attained by the specimens after transfer to lactophenol. The thickened middle portion of the body (Fig. 1) shows 4 longitudinal

* This work has been carried out with the aid of a grant from the Empire Marketing Board.

grooves which are deeper and broader along the lateral lines than along the dorsal and ventral lines; in addition the cuticle is traversed my numerous somewhat coarse transverse striations. The unswollen anterior portion of the body is from 1.7 mm. to 2.2 mm. long, and the unswollen posterior portion of the body is 1 mm. to 1.2 mm. long. No head papillae surrounding the mouth were observed. A pair of

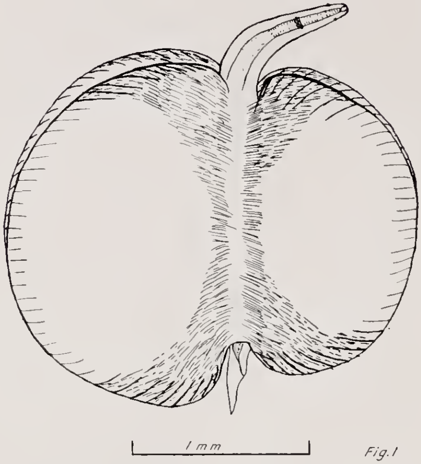

Fig. 1

Fig. 1.—*Tetrameres paradisea* sp. nov. Entire female after fixation in hot alcohol.

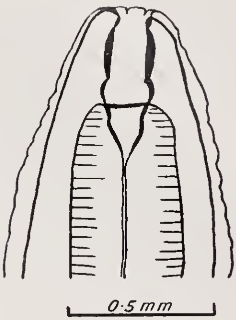

Fig. 2

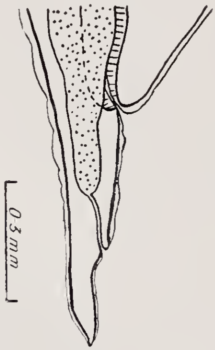

Fig. 3

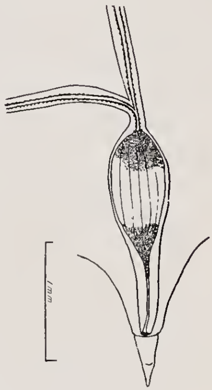

Fig 4

Fig. 2.—*Tetrameres paradisea* sp. nov. Cephalic extremity of female.
Fig. 3.—*Tetrameres paradisea* sp. nov. Posterior extremity of female.
Fig. 4.—*Tetrameres paradisea* sp. nov. Female genitalia, ventral view.

lateral cervical papillae are found from 0.1 to 0.11 mm. from the anterior end. The mouth is terminal and is provided with two very indistinct and trilobed lips; it leads into a buccal capsule, whose thickened wall appears to be built up to three hoops placed one on top of the other (Fig. 2); the most anterior hoop is very small and

forms the inner lining at the base of the mouth; the second hoop is the largest and the posterior hoop has its walls more arched; the entire capsule is from 0.027 to 0.03 mm. deep by 0.017 to 0.018 mm. broad, including the thickness of the capsule.

The anterior end of the lumen of the oesophagus is enlarged to form a small oesophageal funnel about 0.025 mm. deep; its cuticle is thickened on its anterior margin to form a ring on which the buccal capsule rests. The oesophagus, which consists of a muscular anterior portion and a glandular posterior portion, is remarkable for its length, constituting about one-third of the entire length of the worm; its entire length is from 2.5 to 3 mm. long. The muscular portion (=pharynx of Cram) is from 0.397 to 0.41 mm. long and is about twice as thick at its distal end as at its proximal end; the nerve ring encircles it just behind its middle. The position of the excretory pore was not located. The glandular oesophagus is from 2.1 to 2.6 mm. long and increases gradually in thickness posteriorly; at its proximal end it is about 0.08 mm. thick and at its distal end 0.28 mm. The intestine is a much distended sack into which the posterior end of the oesophagus is sunk. It is lobulated and black. The tail (Fig. 3) is straight and pointed and is from 0.2 to 0.215 mm. in length. The vulva is a rounded aperture and its position is indicated by a sudden constriction of the body on the ventral side, about 0.63 mm. from the tip of the tail. It leads into a vagina, 1.7 to 2 mm. long, whose proximal portion is capable of considerable dilation to act as an egg-chamber or vestibule (Fig. 4); its internal surface is lined by cuticle which is thrown into longitudinal folds. The " trompe " is Y-shaped, its short common trunk, about 0.02 mm. long, arising from the proximal end of the vestibule. The limbs of the Y are at least 2 mm. long and they pass directly into the two uteri; these latter are very long and much coiled, occupying most of the distended portion of the body; at their proximal ends they are terminated by a pyriform receptaculum seminis. The eggs are oval, smooth and thick-shelled and are embryonated *in utero*; they are from 0.05 to 0.053 mm. long by 0.03 to 0.032 mm. broad.

The single *male* is 5.8 mm. long with a maximum thickness of 0.14 mm. at its middle; it tapers off towards both extremities. The mouth is bounded by two lateral trilobed lips, each lobe showing 2 to 3 bright refringent markings towards its free border. There are a pair of well-defined lateral alae extending down the length of the body as far as the level of the cloaca; posteriorly these alae become very narrow; they are pierced by a pair of cervical papillae 0.085 mm. from the anterior extremity. On each side of the body, and placed parallel to the alae, is a series of 46 spines directed backwards; in the region of the muscular oesophagus four of these spines are found dorsal to the ala on the right side and five dorsal of the ala on the left side; all the remaining spines are situated ventral of the alae (Figs. 5 and 6). Posteriorly the distances between the spines become greater until near the region of the cloaca, when the spacing becomes smaller and the spines are also smaller. The cuticle bears fine transverse striations, but anterior of the cloaca the ventral surface shows transverse grooves in addition; between these grooves the cuticle is raised into a number of short and parallel ridges. The mouth capsule

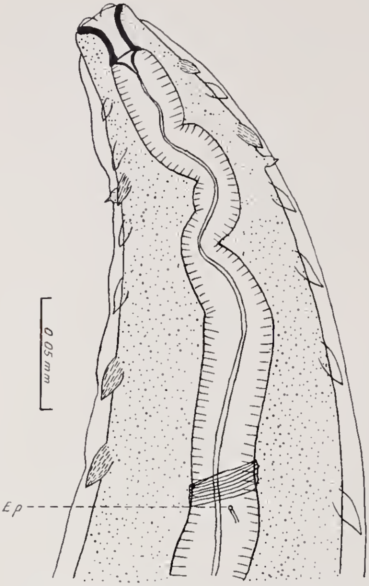

Fig 5

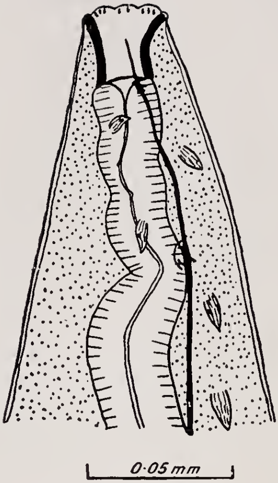

Fig. 6

Fig. 5.—*Tetrameres paradisea* sp. nov. Anterior extremity of male, ventral view.
Fig. 6.—*Tetrameres paradisea* sp. nov. Anterior extremity of male viewed from left side.

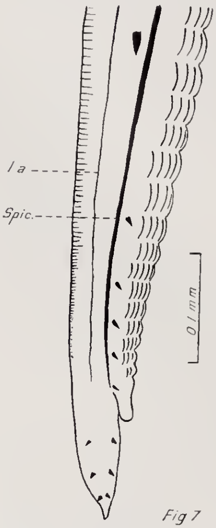

Fig 7

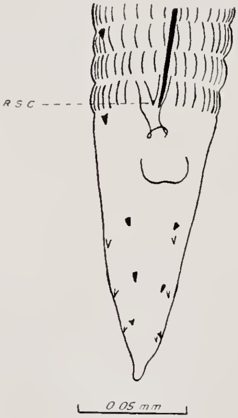

Fig 8

Fig. 7.—*Tetrameres paradisea* sp. nov. Caudal extremity of male, lateral view. L.A. = lateral ala; spic. = spicula.
Fig. 8.—*Tetrameres paradisea* sp. nov. Caudal extremity of male, ventral view. R.S.C. = right spicular canal.

is quite different in shape to that found in the female, being composed of one part having its edges turned outwards anteriorly (Figs. 5 and 6). It is laterally compressed, 0.025 mm. deep, and having at its middle a lateral diameter of 0.012 mm. and a dorso-ventral diameter of 0.018 mm.; its posterior margin is thickened to form a ring which rests on the anterior face of the oesophagus. The anterior portion of the lumen of the oesophagus is dilated to form a small funnel. The muscular oesophagus is 0.31 mm. long, and is encircled by the nerve ring at about the junction of its second and last thirds. The excretory canal and pore is found some 0.015 mm. behind it. The muscular oesophagus, which is 0.9 mm. long, increases gradually in size to attain a maximum thickness of 0.082 mm. at its posterior end. The cloacal aperture is situated 0.115 mm. from the posterior extremity; it is found in a depression about 0.02 mm. deep formed by a posterior elongation of the anterior lip of the cloaca. The tail is pointed and conical and is devoid of cuticular expansions and papillae (Figs. 7 and 8); it carries twelve cuticular spines, six of which are on its ventral surface, and three dorso-externally on each side. Only the left spicule is present, which is long, straight and pointed, measuring 0.69 mm. in length; 0.06 mm. from its proximal end it shows a half twist and from this point a narrow ala extends backwards for about 0.3 mm. Although a right spicule is absent, there is a well-defined spicular canal which is lined by cuticle, and which together with that of the left spicule forms a Y-shaped structure leading into the cloaca.

Host: *Tetrapteryx paradisea.*

Situation: Proventriculus.

Locality: Cape Province, South Africa.

Types to be deposited in the Helminthological Collection, Onderstepoort.

Affinities.

Of the 21 described species of the genus *Tetrameres*, as defined by Cram (1927), of which the male and the nature of the female genitalia are known, only two species, namely *T. dubia* Travassos, 1917, and *T. micropenis* Travasos, 1915, have two rows of body spines in the males and do not possess a copulatory receptaculum in the female. The species described above differs from *T. dubia* in that the latter has its spines confined to the anterior end of the body and in that its eggs are provided with polar filaments; and it differs from both these species in having only one spicule. *T. paradoxa* (Diesing, 1836), Travassos, 1914, has the same type of female genitalia as the new species, but it differs from it in also possessing two spicules; unfortunately the arrangement of the body spines in the male is not described. The female genitalia of *T. coccinea* (Seurat, 1914), Travassos, 1914, and *T. cochleariae* Travassos, 1917, are also of the same type, but unfortunately the male of these two species is unknown. Seurat's species, however, differs from the writer's in possessing a very short vestibule (0.45 mm. against 1.7 to 2 mm.) and a much shorter " trompe " (1 mm. against over 2 mm.) and the eggs are much smaller (0.028 to 0.03 mm. by 0.015 to 0.018 mm.); Travassos' species

is much smaller (3-4 mm.) and its oesophagus is less than half the length of that found in the writer's material. The only species possessing a single spicule is *T. nouvelli* (Seurat, 1914), Travassos, 1914, which species differs from that of the writer in possessing 4 rows of body spines in the male and polar filaments on the eggs.

[Unfortunately the literature pertaining to *T. gallineus* Suginoto, 1923 (Japanese), *T. skojabini* Panowa, 1926 (Russian) and *T. zakharovi* Petrow, 1926 (Russian), was not available.]

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18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

Some Helminths from South African Chiroptera.*

By R. J. ORTLEPP, M.A., Ph.D., Research Officer, Onderstepoort.

THROUGH the kindness of Mr. G. A. H. Bedford of this Laboratory, about 40 specimens of *Miniopterus natalensis*, 11 specimens of *Myotis tricolor* and 6 specimens of *Rhinolophus zuluensis* were placed at the disposal of the writer for examination. From the first named several examples of an undescribed filaria were obtained in addition to two species of the trichostrongyle genus *Anoplostrongylus* Boul., 1926, one of which is new. The second named bat harboured no internal parasites. The last named were all parasitized by an unknown species of the strongylid genus *Strongylacantha* v. Beneden, 1873. It is worthy of note that, although all the bats, except four of the specimens of *Rhinolophus zuluensis*, were collected from one cave, each species of bat harboured its own specific helminths or none at all.

In addition to the above material the writer was also able to examine one female filaria obtained from the body cavity of *Eptesicus capensis*, caught in the lofts of this Laboratory.

The writer wishes to express his indebtedness to Mr. Bedford for placing the above-named bats at his disposal.

Anoplostrongylus alatus sp. nov.

The material examined consisted of one male and four females all collected from one bat; they were unfortunately partially decomposed, and consequently all the details of their internal anatomy could not be made out. The specimens, prior to preservation, were all of a yellowish-red colour and are of small size, the male being 4 mm. long and the females 6 to 6·25 mm. The body tapers gradually towards both extremities. The anterior end of the body carries a cephalic swelling typical of the genus (Fig. 1); this swelling is 0·045 mm. long by 0·03 mm. broad in the male and in one of the females it is 0·044 mm. long by 0·04 mm. broad. Unfortunately the anterior ends of the other three females were too decomposed to show this structure. On either side of the body, extending from immediately behind the cephalic swelling to the posterior extremity in the female and to the bursa in the male, there is a conspicuous and relatively wide ala having a maximum width in the male of 0·022 mm. and in the female of 0·04 mm.; these alae are marked by characteristic transverse thickenings for their whole length, these giving them a combed appearance which is very marked in the middle half of the body.

* This work has been carried out with the aid of a grant from the Empire Marketing Board.

Including the alae the maximum lateral thickness of the body of the female is 0·2 mm. and the dorso-ventral thickness 0·12 mm. These dimensions for the male are respectively 0·105 mm. and 0·067 mm. In addition to these alae the cuticle carries a number of pectinated longitudinal markings and is also finely striated transversely. The mouth is terminal and simple. The structure of the oesophagus and the position of the nerve ring could not be made out. There are symmetrically placed cervical papillae which do not extend beyond the margin of the lateral alae; in the male they are 0·21 mm. from the anterior end. The excretory pore is situated just anterior to these papillae, being found 0·017 mm. anterior to them in the male.

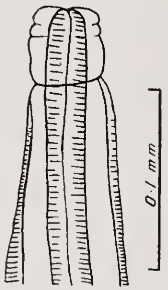


Fig. 1

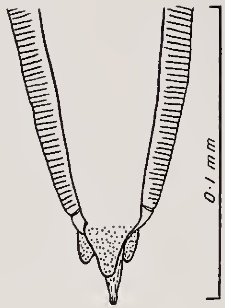


Fig. 2

Fig. 1.—*Anoplostrongylus alatus* sp. nov. Cephalic extremity.

Fig. 2.—*Anoplostrongylus alatus* sp. nov. Caudal extremity of female, dorsal view.

The tail of the female terminates in a spike-like process, 0·026 mm. in length, and carries three blunt processes characteristic of the genus (Fig. 2). These are 0·018 mm. long and are placed one dorsal and two latero-ventral. The lateral alae extend between the latero-ventral and dorsal processes, and just anterior to the origin of these processes they are pierced by the ducts of the caudal glands. The anus is situated 0·09 mm. from the tip of the tail. The vulva is a large transverse slit found in the posterior third of the body, 1·48 mm. from the tip of the tail. A short vagina joins the divergent and muscular ovejectors similar in shape to that found in the other members of the genus. The combined lengths of these, including the sphincters, is 0·33 mm. The uteri are divergent and carry relatively few eggs. The eggs are oval and thin-shelled and vary in length from 0·095 mm. to 0·099 mm. by 0·054 mm. to 0·063 mm. in breadth.

The bursa consists of two large lateral lobes and a very small dorsal lobe (Fig. 3). Its ventral surface is covered with spike-like chitinous processes except towards its margins and on the area bounded by the externo-dorsal rays. The ventral rays originate from a common stem and their tips are divergent, the ventro-ventral ray being thinner than the latero-ventral ray. The lateral rays also arise from a common stem; the externo-lateral ray is of the same size as

the latero-ventral ray and runs parallel with it. The medio-lateral and postero-lateral rays have a common stem, the latter, however, being much thinner; the tip of the medio-lateral ray is directed away from the tip of the externo-lateral ray and the tip of the postero-lateral ray is directed towards the tip of the medio-lateral ray. The externo-dorsal rays are massive and arise from the base of the dorsal ray; they do not extend to the edge of the bursa. The dorsal ray is long and is split down its posterior third; each of these is again split down its posterior third, and the inner branch of these may carry one or two small twigs. The dorsal lobe of the bursa is supported between these inner branches. Prebursal papillae are present, and the length of the bursa from these papillae is 0·165 mm. The spicules are slender, tubular, straight and equal, and measure 0·368 mm. in length; their distal extremities are split into two, the inner branch being blunt and the outer branch

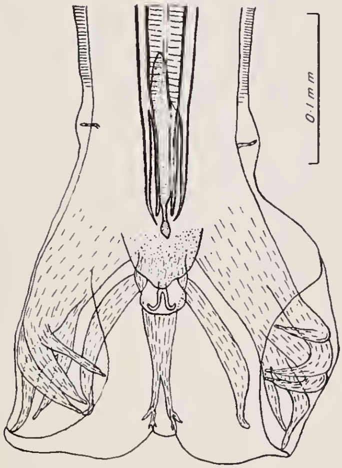


Fig. 3

Fig. 3.—*Anoplostrongylus alatus* sp. nov. Caudal extremity of male, ventral view.

slightly longer and pointed. Both spicules carry conspicuous and transversely striated alae extending from the branching of the spicules to almost their proximal ends. A gubernaculum is present, which is 0·09 mm. long and a shape as illustrated. There is a well-developed genital cone, bearing a membraneous expansion on its dorsal side; this expansion is supported by two papilla-like processes, whose distal extremities are hooked.

Host: *Miniopterus natalensis.*

Situation: Intestine.

Locality: Irene caves, Pretoria.

Types to be deposited in the Helminthological Collection, Onderstepoort.

Affinities.

The members of this genus are now represented by six species, all found in bats. *A. paradoxus* (Travassos, 1921), from Brazil; *A. delicatus* Schwartz, 1927, from Texas; *A. tipula* (v. Beneden, 1873) from Europe; *A. heydoni* Baylis, 1930, from Australia; and *A. ornatus* (Mönnig, 1927) and *A. alatus* sp. nov. from South Africa. The species described above is easily distinguished from all the others in that its spicules are much longer (the longest spicule in the other species is 0·255 mm. in *A. ornatus*) and in that it carries two very conspicuous lateral alae extending practically the whole length of the body.

Anoplostrongylus ornatus (Mönnig, 1927), Baylis, 1930.

One of the specimens of *Miniopterus natalensis* was parasitized by a few specimens of this species. An examination of this material, and a comparison of it with the type material, makes it possible to add the following to Mönnig's description:—

The body carries four longitudinal flanges or alae, two broad and laterally placed and one dorsal and one ventral. These latter two are much narrower than the two lateral. They all take their origin a short distance behind the cephalic swelling and extend to the end of the body in the female and to the base of the bursa in the male. They all show the conspicuous comb-like markings described in the preceding species. In addition to these flanges the body carries twelve rows of finely pectinated longitudinal ridges throughout its whole length; there are three of these ridges between each pair of flanges.

The arrangement of the bursal rays is slightly different to that figured in the original description. The postero-lateral ray takes its origin somewhat higher from the stem of the medio-lateral ray and is much thinner, being only about one-third the thickness of the medio-lateral ray. The ventro-ventral ray is only about half the thickness of the latero-ventral ray. All the rays, except the dorsal, terminate in thin delicate processes. The cuticular spines on the inner surface of the bursa are limited to that part of the bursa supported by the ventral and lateral rays, they being absent towards the edges of the bursa and on the area between the externo-dorsal rays. The papilliform processes supporting the membrane on the dorsal side of the genital cone are similar in shape to those described for the preceding species. The spicules are divided towards their tips, and the tip of the inner branch of each carries a dorsally directed hook, which is only visible when the spicules are viewed laterally; the other spicular branch is slightly longer, and also appears to carry a delicate hook, but this could not be made out with certainty.

Host: *Miniopterus natalensis.*

Situation: Intestine.

Locality: Irene caves, Pretoria.

Strongylacantha pretoriensis sp. nov.

This species was represented by about twenty-five specimens, mostly in good condition. They were all collected from the intestine of *Rhinolophus zuluensis*, all of which harboured this parasite. These bats were obtained from two caves about ten miles distant from each other.

These parasites are relatively stout and have a deep yellowish red colour. The males are from 6 to 6.5 mm. long and the females from 8 to 9·3 mm. long. There is only a slight tapering off of the body towards the extremities in both sexes. In the males the maximum thickness was 0·36 mm. over the middle of the body, 0·3 mm. over the base of the oesophagus and 0·243 mm. at the base of the bursa. In the largest female the maximum thickness over the middle of the body was 0·484 mm., over the base of the oesophagus 0·375 mm., over the vulva 0·462 mm., and over the anus 0·154 mm. The cuticle has

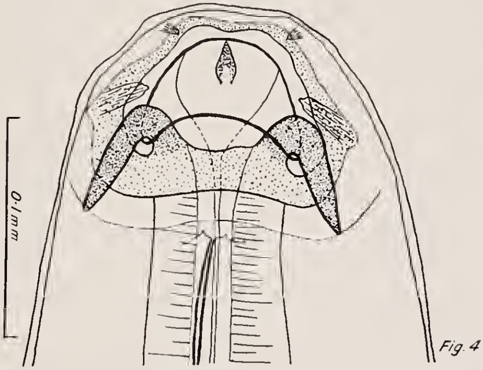


Fig. 4.—*Strongylacantha pretoriensis* sp. nov. Cephalic extremity, ventral view.

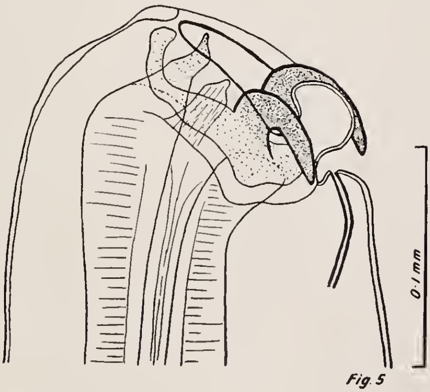


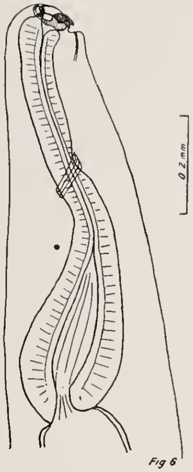
Fig. 5.—*Strongylacantha pretoriensis* sp. nov. Cephalic extremity, lateral view.

fine traverse striations and in addition shows numerous very fine longitudinal striations, which in some longitudinal areas of the body have a wavy course. There are no lateral alae. The two cervical papillae are symmetrically placed and are wart-like; they are found about 0·5 mm. from the anterior end in the male and about 0·55 mm. from the anterior end in the female.

The cephalic extremity is bent slightly ventralwards so that the mouth is directed obliquely downwards. The mouth (Figs. 4 and 5) has a roughly semicircular outline when viewed from the ventral aspect, the convexity of its dorsal and ventral margins being directed antero-dorsally. The ventral convexity of the mouth forms a swollen lip-like structure between the teeth, and is somewhat circular in outline in optical section. The two prominent teeth, characteristic of the genus, take their origin at the ventro-lateral margins of the buccal capsule and pass through the mouth at its ventro-lateral corners. They are large, rounded and recurved backwards and extend out of the mouth for about 0·06 mm. There is a shallow mouth capsule composed of thickened cuticle, which extends downwards to form the lining of the lumen of the oesophagus. The capsule is of varying thickness, being thinnest on the dorsal margin of the mouth and thickest on its ventral margin, where the teeth take their origin from it. It is slightly compressed laterally so that its dorso-ventral diameter is slightly greater than its lateral diameter. The anterior end of the oesophagus is also tilted slightly downwards and its lumen is slightly expanded to form a small funnel about 0·045 mm. deep and 0·05 mm. broad; on its antero-dorsal margin it carries a small tooth, about 0·025 mm. long, having its tip tilted slightly dorsalwards. There are two pairs of cephalic papillae, one pair large and situated towards the ventro-lateral margin of the mouth and the other pair much smaller and indistinct towards the dorso-lateral angles of the mouth. Just behind the mouth, on the ventral surface of the body, there is a chin-like swelling of the body wall, and on the anterior margin of this swelling there is situated the opening of the excretory gland; this opening is lined by thickened cuticle which also extends downwards for some distance to form the lining of the excretory canal. The oesophagus (Fig. 6) is massive and club-shaped and is just over 0·8 mm. long in the male and about 0·9 mm. long in the female. Its anterior half has a roughly uniform thickness of about 0·07 mm., but its posterior half swells out to form a prominent club-line thickening, having a maximum thickness of 0·2 mm. The nerve ring encircles it just anterior to its middle.

The vulva is situated in the posterior half of the body, and divides the body more or less into the ratio of 5:3; it is a rounded aperture about 0·09 mm. in diameter, having its anterior margin slightly raised. The ovejectors (Fig. 7) are large and generally opposed, although in some the posterior ovejector is first bent forwards and then backwards again; their combined length, including the sphincters, is 0·8 mm. The eggs are numerous, oval and thin-shelled and are deposited in the 1 to 4-celled stage. They are from 0·105 to 0·108 mm. long by 0·058 to 0·065 mm. in breadth. The tail (Fig. 8) is short and stout, about 0·125 mm. long and is terminated by a slender spike 0·022 mm. in length. Three conical projections, 0·018 mm. long, are situated round this spike, one dorsal and two latero-ventral in position.

The bursa (Fig. 9) is ample and is composed of two large lateral lobes and a much smaller dorsal lobe supported by the terminal branches of the dorsal ray. The ventral rays arise from a common stem, are closely opposed and extend to the edge of the bursa. The lateral rays also arise from a common stem. The externo-lateral ray is directed away from the medio-lateral ray, and is shorter than the



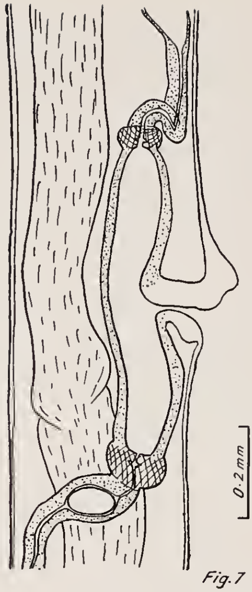
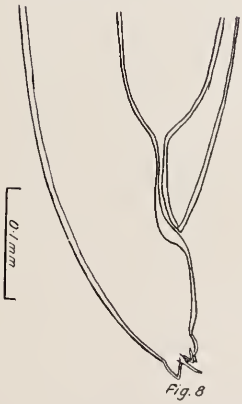


Fig. 6.—*Strongylacantha pretoriensis* sp. nov. Anterior extremity showing oesophagus.
Fig. 7.—*Strongylacantha pretoriensis* sp. nov. Vulva and ovejectors.



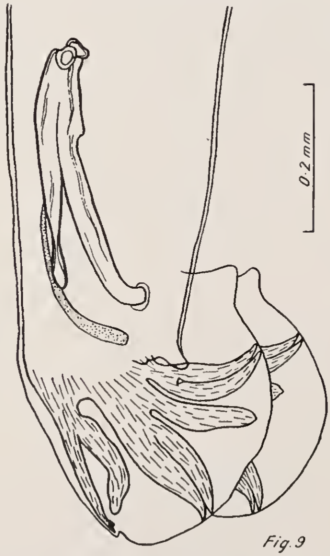


Fig. 8.—*Strongylacantha pretoriensis* sp. nov. Tail of female.
Fig. 9.—*Strongylacantha pretoriensis* sp. nov. Lateral view of bursa and spicules Only one spicule shown.

other lateral rays, not extending to the edge of the bursa. The medio- and postero-lateral rays are of the same size, and run parallel to each other to the edge of the bursa. The externo-dorsal and dorsal rays have a common stem, the former being slightly stouter (Fig. 10); these latter are roughly L-shaped, the base of the L standing at right angles to the dorsal ray; the dorsal ray is long and stout, and its distal end gives rise to six small branches, which may be asymmetrically arranged around its axis. The two spicules are equal, stout, strongly chitinized and ridged; they vary in length from 0.34 to 0.38 mm.; each spicule is composed of a dorsal branch about 0·26 mm. long and terminating in a slightly spathulate tip, and a ventral brach 0·3 mm. long, having its tip very blunt and bent ventralwards. The gubernaculum is boomerang-shaped in side view and is about 0·2 mm. long; its proximal extremity is feebly chitinized. There is a prominent genital cone, about 0·04 mm. high, bearing a nipple-like structure on its summit. There are no genital appendages.

Host: *Rhinolophus zuluensis.*

Situation: Intestine.

Locality: Delmas and Irene caves, Pretoria.

Types to be deposited in the Helminthological Collection, Onderstepoort.

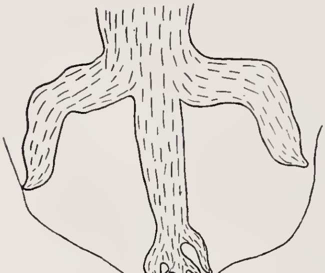


Fig. 10

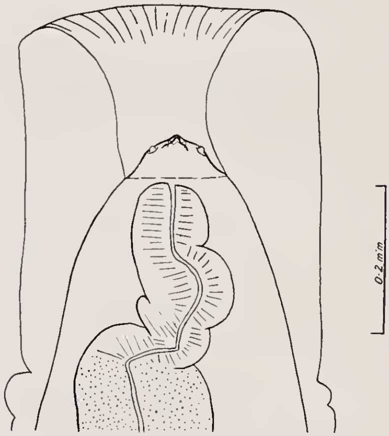


Fig 11

Fig. 10.—*Strongylacantha pretoriensis* sp. nov. Dorsal rays of bursa.

Fig. 11.—*Physaloptera bedfordi* sp. nov. Anterior extremity showing reflexed cuticle.

Affinities.

S. glycirrhiza v. Beneden, 1873, is the only member of this genus which has been described up to the present. Unfortunately van Beneden's description has not been available but from the generic diagnosis given by Baylis and Daubney (1926) and that given by Yorke and Maplestone (1926) with figures, it is evident that the species described above is closely related to van Beneden's species.

S. glycirrhiza, however, is very much smaller, the males being 2-3 mm. long and the females a little longer; the bulb of the oesophagus is not so marked; the excretory pore is not situated on a chin-like thickening, and the tip of the female tail has only two points. Besides these differences Yorke and Maplestone state that in the genotype the externo-dorsal rays arise separate from the dorsal rays, whereas in the new species they have a distinct common stem; further, they state that the medio-lateral and postero-lateral rays are separated, whereas in the writer's material it is the externo-lateral and medio-lateral rays which are separated, whereas the first named two rays are parallel.

Physaloptera bedfordi, sp. nov.

The material of this species consisted of one complete male and female, the posterior extremities of two females and three males ,and two cephalic extremities. The specimens were all mature as the females contained embryonated eggs *in utero* and two specimens were *in copula*. They were all obtained from one of the specimens of *Rhinolophus zuluensis*.

The cuticle is much inflated in all the specimens, and this is probably a normal state of affairs, because, although the worms were already dead when collected, no degeneration had taken place in the internal organs. The swelling of the cuticle is particularly marked at the anterior extremity, where it forms a large and deep prepuce-like covering over the lips (Fig. 11). Over the rest of the body the cuticle is thrown into irregular and coarse transverse folds. The body is relatively stout and tapers slightly from the middle of the body towards the anterior end in both sexes; posteriorly in the male the body decreases only very slightly in diameter so that at the base of the bursa it is 0·45 mm. thick against a maximum body thickness of 0·5 mm. in the middle; this decrease in thickness posteriorly is slightly more marked in the female until the anus is reached when the body becomes sharply rounded off to form a short and stumpy tail surrounded by inflated cuticle. The entire male and female are respectively 6·75 mm. and 9·4 mm. long with a maximum thickness in each, excluding the cuticle, of 0·5 and 0·8 mm. The specimens would probably have been slightly longer had they been properly fixed, but when received by the writer they were somewhat shrivelled. The two lips (Figs. 11 and 12) are rounded and each carries a prominent papilla towards each of its lateral corners. Internally, each carries a large triangular tooth which is somewhat blunt, and internal to it a tripartite tooth, of which the inner prong is slightly shorter than the outer prongs. Lateral denticles are absent. A short pharynx leads into the lumen of the oesophagus. The oesophagus consists of two parts, a muscular anterior portion and a much longer and stouter posterior glandular portion. This whole organ is relatively longer in the male than in the female. measuring 2·7 mm. in the former and 2·8 mm. in the latter. The muscular portion is much shrivelled and in consequence the position of the nerve ring could not be made out. The cervical papillae are small peg-like structures sticking through the cuticle just anterior to the junction of the two oesophageal parts.

The vulva is situated behind the oesophagus, roughly at the junction of the first and second thirds of the body, being found 3·25 mm. from the anterior end; it is non-protuberant. The vagina is thick-walled, 0·4 mm. long by 0·04 mm. thick, and passes backwards to join a large egg chamber, 0·5 mm. long and 0·22 mm. in diameter. The common trunk is relatively long, being 0·75 mm. in length, and its distal end divides into two to join the two uteri, which pass down the length of the body more or less parallel to each other. The eggs are smooth, oval, thick-shelled and embryonated *in utero;* they vary in size from 0·044 mm. to 0·048 mm. long by 0·024 to 0·026 mm. in breadth. The tail is short and stumpy and is slightly tilted dorsalwards; excluding its cuticular inflation it is about 0·1 mm. long.

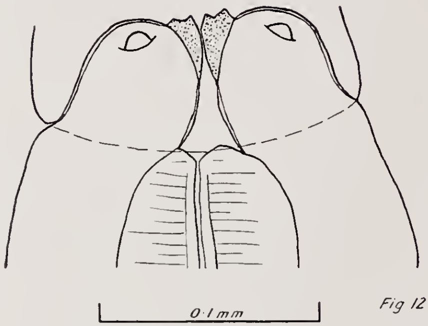


Fig 12

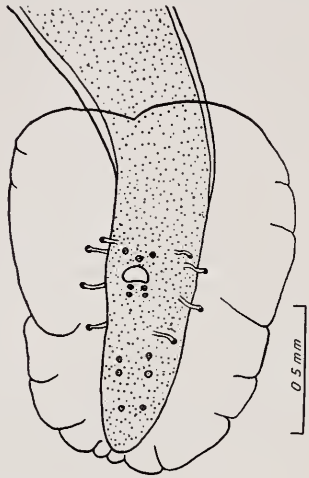


Fig. 13

Fig. 12.—*Physaloptera bedfordi* sp. nov. Ventral view of lips.
Fig. 13.—*Physaloptera bedfordi* sp. nov. Caudal extremity of male.

The " bursa " (Fig. 13) is much inflated and in consequence the fleshy parts of the rugosities on its ventral surface are long drawn out, thus obscuring the caudal papillae to some extent. There are four pairs of lateral stalked papillae, two precloacal and two postcloacal in position. Of the sessile papillae three are precloacal arranged in a flat triangle; two pairs are postcloacal immediately behind the cloaca; two pairs are situated more or less in the middle of the tail, and one pair at about the junction of the third and last quarters of the tail. The arrangement of the caudal papillae, described and figured above, is what is taken by the writer to be the normal arrangement, as some variation to this arrangement was seen; e.g., one specimen had 5 stalked papillae on the right and 3 on the left; the last pair of sessile papillae was seen in only one specimen; the second pair of sessile papillae behind the anus was present in two specimens, but in the other the papilla on the left side was absent and that of the right side was fused to the preceding one. The spicules are very feebly chitinized, and their length and shape could in consequence not be

definitely made out. They are, however, short and unequal, the left about 0·12 mm. long and tapering gradually to a point, and the right about 0·07 mm. long; the posterior half of the latter appears to be slightly broadened out to finally taper to a point.

Host: *Rhinolophus zuluensis.*

Situation: Stomach.

Locality: Irene caves, Pretoria.

Types to be deposited in the Helminthological Collection, Onderstepoort.

Affinities.

Up to the present only two species of *Physaloptera* have been reported from bats, namely, *P. brevivaginata* Seurat, 1917, from North African bats and *P. retusa* Rud., 1819, from South American bats; this latter species is normally a parasite of reptiles. The species here described differs from Seurat's species, of which only the female is known, in that its vulva is more anterior in position, being found just anterior to the middle of the body in *P. brevivaginata;* the vagina is longer, 0·4 mm. against 0·3 mm.; the egg chamber is shorter and a long common trunk is present, which structure is absent in Seurat's species. It differs from Rudolph's species by its much smaller size, the nature of its teeth, the different arrangement of its postcloacal sessile papillae and by its shorter spicules. The cuitcular inflation also separates it from the two older species.

In comparing this species with the known didelphic forms of this genus, it would appear that the apparent shape and structure of the spicules allies it to *P. retusa* Rud.; this is probably a coincidence rather than a sign of affinity, especially as Rudolphi's species is not represented on this continent; besides, the distinguishing characters enumerated above definitely serve to show that these species are not closely related. The peculiar nature of the " bursa " and the indefinite arrangement of the caudal papillae places this parasite in a somewhat isolated position among the known didelphic representatives of this genus.

Litomosa chiropterorum sp. nov.

Several of the specimens of *Miniopterus natalensis* harboured this parasite. They were found adhering to the abdominal viscera and were all in a good state of preservation.

The parasites are long, white and thread-like, the females attaining a maximum length of 77 mm. and the males 35 mm. The body, except towards the posterior extremity of the male, has a more or less uniform thickness. The largest female had a maximum thickness of 0·17 mm. and the largest male 0·11 mm. The cephalic extremity is bluntly rounded and smooth, no papillae being present. The cuticle is also smooth. Lips are absent, the mouth aperture being rounded and opening directly to the exterior. There is a definite buccal capsule (Fig. 14), whose internal shape is somewhat flask-shaped; its maximum depth is 0·019 mm. with a maximum internal diameter of 0·008 mm.; the capsule itself bears externally a well-developed hoop-like flange, which rests on the anterior surface of the oesophagus;

below the flange the capsule is continued downwards into the anterior portion of the lumen of the oesophagus. The oesophagus (Fig. 15) is muscular throughout and measures about 0·5 mm. in the largest females and 0·4 mm. in the males; at its anterior extremity it has a thickness of 0·03 mm. and it increases gradually posteriorly to attain a maximum thickness of 0·042 mm. at its posterior extremity. The nerve ring incircles it just anterior to its middle, being located about 0·23 mm. from the anterior end. The excretory pore is found on the same level as the nerve ring, and a short thin excretory duct passes obliquely inwards and backwards from it to join a large and somewhat convoluted excretory gland, extending posterior of the oesophagus for about 0·3 mm. in one of the females.

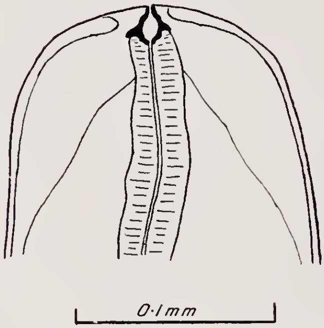


Fig. 14

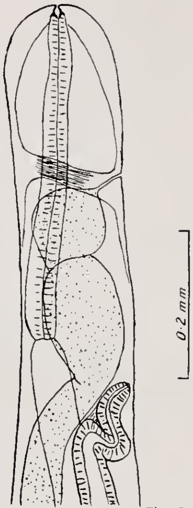


Fig. 15

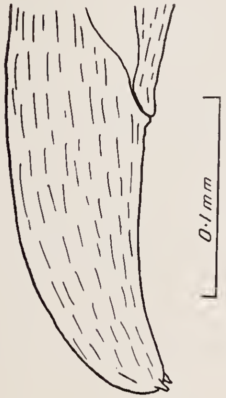
Fig. 14.—*Litomosa chiropterorum* sp. nov. Cephalic extremity showing buccal capsule.

Fig. 15.—*Litomosa chiropterorum* sp. nov. Anterior portion of body showing oesophagus and vulva.

The position of the vulva is indicated by a slightly raised portion of the body-wall just behind the oesophagus; it is a small rounded aperture 0·51 mm. from the anterior end in a 40 mm. long female; it leads to a long and muscular ovejector, which passes down the body parallel to the intestine eventually to join the two uteri, which extend down the posterior portion of the body. The tail (Fig. 16) is conical and bluntly rounded, and bears two spike-like structures on its tip, one towards each of its ventro-lateral angles; it is about 0·13 mm. long.

The posterior extremity of the male is spirally coiled clock-wise and is devoid of any cuticular structures such as alae and papillae; it is very similar to that of the female except that the two spike-like structures are absent; it is about 0·09 mm. long. There are two well-developed and markedly dissimilar spicules (Fig. 17), of which the

left is about three times the length of the right. The right spicule is 0·115 mm. long with a thickness of 0·013 mm. at its proximal end; it tapers slightly towards its distal end, which is differentiated to form a spatula-like structure with tapering apex and appearing as if it was cemented on to the end of the spicule; dorsally and just anterior to this structure it carries a small longitudinal flange. The left spicule is 0·31 mm. long and 0·017 mm. broad at its base; its distal portion is very much narrowed to form a lash-like structure about 0·14 mm. long.



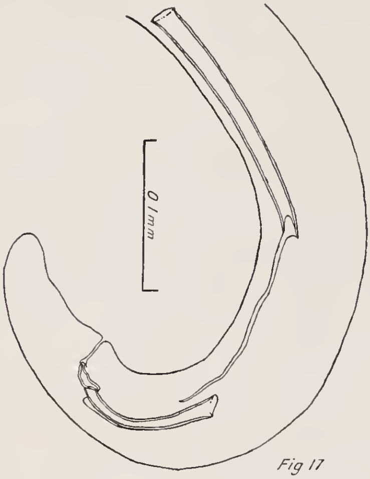


Fig. 16.—*Litomosa chiropterorum* sp. nov. Caudal extremity of female.
Fig. 17.—*Litomosa chiropterorum* sp. nov. Caudal extremity of male showing spicules.

Host: *Miniopterus natalensis.*

Situation: Abdominal cavity.

Locality: Irene caves, Pretoria.

Types to be located in the Helminthological Collection, Onderstepoort.

In addition to the above material one female specimen of this species was obtained from the abdominal cavity of the house bat, *Eptesicus capensis.*

Affinities.

The only described species of this genus is *L. filaria* (v. Beneden, 1873), Yorke and Maplestone, 1926, from *Vespertilio auritus*, Europe. From the available information and illustrations it is clear that the new species is very closely related to this species, from which it can, however, be differentiated by (1) the nature of the buccal capsule, which is flask-shaped and not infundibuliform, (2) the presence of a hoop-like flange on the external wall of the capsule, (3) the absence of a small terminal spike on the tail of the male, and (4) the absence of two small spines between the two processes on the tip of the female tail.

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Distribution of Glossina in the Bechuanaland Protectorate.

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(Seconded to Bechuanaland Protectorate Administration November, 1930, to February, 1931.)

INTRODUCTION.

Although *Glossina morsitans* or tsetse has been known to exist in Ngamiland for over 70 years, it is astonishing what little information is available regarding its distribution, bionomics, etc. Even Newstead, in his excellent memoir (1924), omits Ngamiland in his map of distribution.

ORIGIN OF THE WORD "TSETSE".

As Crawshay remarks (1903), the word is of Bantu origin. It has been used by the Bamangwato tribe of Bechuana stock from time immemorial and is now incorporated in many European languages. When a portion of the Bamangwato tribe under Chief Tawana occupied the country around Lake Ngami "about the year 1800" (Stigand) and established themselves as the dominant people (calling themselves Batawana, literally, followers of Tawana), the word was handed on to the subject tribes, the Bakuba, Bakalahari etc [1]. The word refers not only to the genus Glossina, but also to the disease or rather group of diseases caused by this insect, a rather unfortunate state of affairs. The word "fly" used by many Europeans is equally unsuitable.

In Zululand, on the other hand, the natives possess no term for Glossina, but the word Nagana is used for the diseases produced. On investigation it has been ascertained that the actual organisms responsible are *T. congolense*, *T. vivax* and *T. brucei* (Curson 1924).

HISTORY UP TO 1896.

Apart from Austen (1903), who endeavours in his Glossina map of Africa to show the distribution of tsetse, no one has attempted to deal with the position in Bechuanaland Protectorate. Austen's map is too small and is apt to confuse rather than instruct. His collection of references, however, is invaluable, especially to workers who do not have access to old established libraries. Jack (1914, 1918, 1920, 1927) and Fuller (1924) have interested themselves in the distribution of fly in the adjoining territories of Southern Rhodesia and Transvaal respectively, and in this paper a similar attempt will be made with regard to Bechuanaland Protectorate.

Reference will be made to the eastern border, first along the Transvaal and then along the Southern Rhodesian boundary, also to the northern border and finally to the Okovango Delta in the heart of Ngamiland. (See Map A.)

Eastern Border.

Commencing at the south, it is seen from Fuller's description that, although fly was encountered by Harris in 1836 *along the Limpopo River* (Crocodile River section) from Hartebeest Poort (Magaliesberg) to Brits (Swartkoppies), he (Fuller) did not believe that the pest penetrated "west of the Limpopo until the latitude of the Macloutsi River" was reached (p. 330). In fact, he concluded from the travels of hunters such as Cumming and Oswell that tsetse was absent "from the forest avenue of the Limpopo" (p. 349), a most unlikely state of affairs.

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[1] About 40 years later (1843) the Basuto Sebitwane, brother of Moshesh, passed through Ngamiland to the Zambesi Valley and subjected the local tribes. Sesuto-Sechuana is thus firmly established in this part of Africa.

There is, however, evidence from Cumming's first journey along the Limpopo in 1846 that his oxen contracted Nagana while he was at Selika's Kop (about 10 miles west of the Limpopo) from 17th October to 15th November. If infection took place before that, then, as Fuller himself suggested, it might have occurred "when in the neighbourhood of the Lotsani" (p. 327). It is of course possible while Cumming was at the "camp near a Bakalahari village below the Lotsani" that he took his oxen across to what is now the Potgietersrust magisterial district and there infection occurred.

A. C. Bailie, quoted by Fuller (p. 338), who wrote in 1878 that fly had existed between Shoshong to the Magalapye River was probably correct. Fuller, however, dismissed his statement as follows: "Bailie wrote on hearsay evidence, and was in error as regards this locality. The information he gathered may have related to some other locality".(2)

Although it was in 1871 that Theunis de Klerk told Baines that he "thought that the fly was a curse that was being removed from the country" (Fuller p. 337), it is probable this process had been in operation for a generation or more, indeed prior to the coming of Harris. In any case, the topographical features of the Limpopo Valley suggest that the view expressed by Bailie was correct, especially as it is known that Glossina extended up the Crocodile River to Hartbeest Poort, and along its tributary, the Pienaars River, to near the present railway station of that name(3). Finally it should be remembered that one may travel in Glossina country and yet be unaware of its presence.

It may therefore be reasonably assumed that tsetse occurred along the left bank of the Limpopo River south of the Shashi River, but its southward and westward extensions are unknown. Actually Baines met fly between the Macloutsi and Pakwi Rivers on his return to the Transvaal from Lobengula in 1871.

Along the Southern Rhodesian border, i.e. between the Limpopo and Zambesi Rivers, Jack (1914) discusses the distribution of Glossina prior to the Rinderpest epizootic of 1896. This is based mainly on the information provided by Austen, and indicates fly areas (*a*) along the north bank of the Limpopo between the Shashi and Nuanetsi Rivers; (*b*) along the Ramaquabane River, east of Francistown; (*c*) along the Deka River, a tributary of the Zambesi; and (*d*) along the Zambesi itself from the Gwaai River to Kazungula. Selous, who examined this map(4), "expressed his conviction that there was no fly in any part of" the area (*a*) in 1896. Fly, however, was then present at the junction of the Shashi and Shashani Rivers(5) and along the Limpopo east of the Nuanetsi River.

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(2) Mr. W. Hay, M.R.C.V.S., Acting C.V.O., Bechuanaland Protectorate, has obtained from a Mr. Clarke more definite information regarding fly in the Lotsani area in 1872.

(3) Ideal cover would be provided by vegetation such as *Zizyphus mucronata*, *Combretum erythrophyllum*, *Acacia horrida*, *Royena pallens*, *Gymnosporia buxifolia*, etc.

(4) See reference, Jack (1914), p. 100.

(5) Note Baines' reference (1877) to tsetse near the Shashi River (quoted by Austen, p. 164). Note Coryndon's record, 1896, in Jack's map of 1927.

Eight years, however, prior to this, Keane (quoted by Austen, p. 201) referred to, " A tsetse belt 40 miles wide along the whole course of the Limpopo ". Jack (1918) represents the northern boundary on his revised map as stretching from just north of Tuli north-east to the confluence of the Tokwe and Lundi Rivers. If such was the case, it strengthens the view that fly extended west into Bechuanaland Protectorate. From what has been stated above, fly had apparently disappeared from the area between the Shashi and Nuanetsi Rivers by 1896. Further, Selous stated he had " never known fly to occur in the Ramaquabane area (*b*), and finally he maintained that the belt (*d*) i.e. " west of the Victoria Falls had disappeared by 1888 ". With regard to this same area Jack later (1920) shows that " fly was numerous between the Falls and the Zambesi-Chobe Confluence in 1893, and it is apparent that an increase of fly took place subsequent to 1888 ". His authority(6) gives valuable information regarding the former occurrence of tsetse between Deka and the Zambesi. In the early sixties fly existed all along the Deka-Zambesi Road (i.e. to Kazungula), about the middle seventies(7) the pest " had receded further north somewhere north of Gazume Vlei ". In 1893 " ox transport was left at Gazuma, but fly was found between Leshuma and Kazungula ". Jack (1918) in his later map, shows the former range of Glossina south of the Zambesi as extending from the Bechuanaland Protectorate border eastward to the Gwelo district along a line corresponding more or less to latitude 19°. It is probable this line could be extended west well into the Protectorate, for it is significant Chapman in 1862 believed that fly occured along the Zambesi River from the Gwaai Confluence west to the Thamalakane River into Ngamiland. According to Bradshaw (quoted by Austen p. 184) in 1881 tsetse were to be met with about 100-110 miles south from Kazungula along the western Hunters Road.

The last contribution to the subject was in 1927 when Jack read a paper before the South African Association for the Advancement of Science at Salisbury. His map is important in that it shows the former distribution of Glossina in Bechuanaland Protectorate north of the Limpopo (limit of Carl Mauch 1865) as a line approximately west of the Shashi-Shashani Confluence.

Thanks to the kindness of the same authority a map illustrating the present distribution of tsetse in Southern Rhodesia accompanies this paper. (See Map B.) The map indicating the position in Northern Rhodesia was obtained through the kind offices of Mr. L. W. G. Eccles, Deputy-Director of Surveys at Livingstone. (See Map C.)

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(6) A report by Cattle Inspector Giese to the Chief Veterinary Surgeon, dated 9th July, 1918.

(7) According to Mohr (quoted by Austen, p. 149) fly was encountered in 1870 " 5 nautical miles " of latitude " 19° 10′ 51″ S.", i.e. not far north of Hendricks Pan. See Holub's references (Austen, pp. 176-181). Also Hornor's reference to fly near Kazungula (quoted by Austen, p. 175).

Northern Border.

It is quite clear from the accounts of Livingstone (1857), Kirk (1865), Chapman (1868), Selous (1881), Cotton Oswell (1894) and Schulz and Hammar (1897), all quoted by Austen, that Glossina was present along the south bank of the Chobe, from its confluence with the Zambesi at Kazungula, west, in a direct line, for over 100 miles. The westerly limit is not definitely given, but Schulz and Hammar, who travelled along the south bank of the Chobe River in 1884, refer to the " swarms of fly " along the Lower Chobe River as do others, and to the presence of the pest at the confluence of the Luiana and Chobe Rivers in Chief Jeluka's country in what is to-day Angola. Whether this area was ever connected with the Lower Chobe area through Caprivi Strip (South-West Africa Protectorate) is not certain, but it is probable that such was the case.

Okovango Delta.

It was apparently Andersson (1856) who first described fly in the Okovango Delta. Austen quotes (p. 128) as follows:—" During my hunting excursions along the Teoge, I encountered, for the first time, that most extraordinary of insects, the Tsetse (*Glossina morsitans*, Westw.). Further on, one reads that a party of Griquas hunting to the N.W. of Lake Ngami " lost, prior to their return to the Lake, all their cattle by the bite of the Tsetse ", and in the same year " a party of Englishmen . . . ' attempting ' to reach Libebe . . . had only proceeded seven or eight days journey to the north of the Ngami, when both horses and cattle were bitten by the fly in question . . .". These references indicate that fly occurred between Tsau and Nokanen, but another quotation, from Austen (p. 179) relating to Père Duparquet (1881), makes it definite that the pest occurred at the junction of the Taoge River with the Lake, i.e. *about 5 miles south of Sihitwa store.* Baines (1864), who accompanied Chapman, also met fly along the Taoge River, for he wrote, " This is not unlikely to be the Teoge River, and if so, it would not do to take the cattle near it on account of the fly ".(8)

Livingstone (1857) came into contact with Glossina approximately 30 miles north-east of Lake Ngami, i.e. at the southerly part of the eastern side of the Okovango Delta, viz.:—Kganstan at the junction of the Thamalakane, Lake and Botletle Rivers. Farther north along the same border he again encountered the scourge at Mababe, as did Arnot in 1882 (quoted by Austen, p. 129 and p. 202).

Chapman (1868), as a result of his journey in 1862 (quoted by Austen p. 143), expressed the view, " there must be ' fly ' from near the west bank of the Gwaai all the way to the Victoria Falls, and beyond to the junction of the Tamalukan or Lingalo's River, near Lake Ngami ".

(8) Moodie (1888), refers to the Boers of the " Dorsland Trek " losing cattle (in the 'seventies) through fly north of Lake Ngami. The map at the end of the volume shows fly *west* of the Taoge River. Stigand writes (16th July, 1931) that the older Batawana headmen maintain that as a result of game destruction by these Boers, fly " disappeared from Tsau and the area west of the Taoge River . . . .". Similarly, that fly disappeared after Rinderpest. Dr. Siegfried Passarge (" Die Kalahari ", Dietrich Reimer—Ernst Vohsen—Berlin, 1904) refers on p. 446 to tsetse just south of Andara before the Rinderpest epizootic.

Sufficient has been stated to indicate that in pre-Rinderpest days fly was widely distributed along the eastern and northern borders of the Protectorate and indeed in the Okovango Delta. It is evident fly extended and receded (as it does at the present day), but apparently from 1896 for a decade or so, the plague was quiescent, and two fly areas definitely became recognized, the Okovango and the Chobe.

Below it is intended to give details as to the extension which has been occurring for the past generation, and which led to the appointment of a Commission in 1930 to study the problem.

DISTRIBUTION SINCE 1908.

As will be seen in Map D, there are two fly areas, the Okovango and the Chobe. Above, the history of Glossina was taken up to 1896, when, as a result of Rinderpest, it is believed the pest receded to unprecedented limits.

For about 12 years it would appear that Glossina was very little evident. In fact it was not until the report that "gotsello" was prevalent in the Okovango Marshes (along the Boro River) in 1908, that any notice was taken of fly.(9) Lieut. H. W. Hannay, while visiting, early in 1909, a suspected area Qamazuro, approximately 100 miles in a northerly direction from Tsau(10) collected specimens of Glossina which were submitted to Dr. R. W. Moffatt (who investigated the outbreak) and Mr. E. E. Austen, who identified them as *G. morsitans*.

Again *in 1909*, Hannay, accompanied by Messrs. Woosnam and Legge, visited the country west of the southern end of Mababe and reported "on former patrols I made the journey by scotch cart, but now for the first time for many years, the tsetse fly has appeared on the left bank of the Mechaba (Mochaba or Kudumane of Stigand's map of 1923), causing the natives to remove all their cattle posts further east and necessitating my employing carriers at Shaleshanto's village in order to visit that part of the country "(11). With regard to this district Major F. C. Garbutt (quoted by Fuller, p. 365) reported that "the fly only appeared in this area after the extremely heavy rains experienced in 1909, which filled up the dry beds of rivers that had ceased to flow. The belt increased from five miles the first year to twenty miles in 1918 "(12). Actually the area referred to by Major Garbutt is on the old wagon road (west of the Mogogelo River) from Maun to Kazungula south of the Mababe Depression. It is thus evident that up to 1909 the spread of Glossina was noticed only in the north-east angle of the Okovango Fly Area, viz., Mababe area.

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(9) See *Sleeping Sickness Bulletins*, No. 9, p. 348, and No. 12, p. 492 (1909).

(10) In Zululand *G. pallidipes* attracted notice from 1910. Since Zululand was also affected by East Coast fever in 1903 onwards, this later manifestation can be explained.

(11) Report written at Tsau 2nd September, 1909. See file at Maun, to which place the "capital" was moved in 1915.

(12) File N./89/519, Maun, states that the belt was 20 miles in extent by 1916.

During the next period, i.e. *between 1909 and 1916*, encroachment occurred at the following points:—(*a*) South of Mababe along the Xusa sector. As stated above, the original tongue or belt of infested country increased from five miles to approximately 20 miles, thus making the Maun-Kazungula wagon road decidedly dangerous for transport purposes; (*b*) southwards along the Tsau-Salasamore-Maun road([13]) in 1914; and (*c*) eastwards along the Lower Boro River. Apparently no complaint was received with respect to this area until 1916, just a year after the headquarters of the Batawana tribe had been removed from Tsau to Maun, when Chief Mathibi reported his fears to the Magistrate. He urged that as fly was encroaching, apparently eastwards along the river, that a game drive be organized "to drive the game back into the swamps" and that the country be burnt at the same time. Although ammunition was approved by the Authorities for this service, it is now recognized that such a measure, unless systematically held over a long period, is of no value([14]).

The next valuable piece of evidence as to the extension of Glossina was the mapping of the Chobe and Okovango Fly Areas, the position being represented as in 1921. Stigand (1923) who performed this task had made observations regarding the occurrence of fly during a lengthy survey of Ngamiland, and it is evident that considerable encroachment had taken place, i.e. in respect to the Okovango area, northwards, southwards and eastwards.

As the cattle export trade to Northern Rhodesia via Kazungula commenced in 1920, it was imperative for steps to be taken to make the Maun-Kazungula road safe for stock. An attempt was made in 1920 to widen the route along the west bank of the Mogogelo River, but as this was ineffective, a road along the east bank was cut the following year. Since, however, Glossina was also present to the east of the Mogogelo River, it is not clear why the road was taken so near to it. At the present day this same road serves as the dry weather motor road.

The years *1921 to 1925* may be taken as another period admittedly arbitrary, in which to trace the spread of fly. Owing to the heavy losses through Nagana contracted while export cattle were travelling along the eastern Mogogelo road, a new route was selected in 1924, the so-called Riley's Road. It is understood that this was first taken by the Damaras of Chobe district when they migrated southwards to the Botletle River, its direction being east of the Mababe Depression and Xusa fly-belt, and its point of junction with the eastern Mogogelo road being at Rakuku, i.e. south of the fly-belt. After the rains have commenced, Riley's deviation is now used by motor traffic, since even after a storm or two the Mababe route is impassable. The first half of the period in question was probably the most difficult in the history of Ngamiland, the mortality as a result of Glossina being so serious that the Government forbade the use of the eastern Mogogelo road for its transport, and cattle for

([13]) Also known as the Paradise road.

([14]) It was intended to have game drives in 1930, but apparently through lack of interest the matter was dropped. It will be noted that a drive took place in 1916.

export were driven through the Xusa area by night in order to avoid infection. In fact, it was suggested by the Authorities more than once that the Serowe route, i.e. the southern road to the railway, be reopened. By the use of Riley's Road, the position was alleviated, but only for a short time, for the Xusa belt continued to extend southwards, forcing the natives about Rakuku to flee towards Maun, with the result that the Mogogelo Store was closed down about this period. There is, of course, the possibility that fly was present in the immediate neighbourhood of Rakuku in 1924, and that a thorough search would have proved successful, for *G. morsitans* is well known as an elusive insect.

Attempts were made in 1925 and again in 1926 to widen the eastern Mogogelo road in the vicinity, especially of Rakuku, but as would be expected, these were failures. Actually in places the road was only about 25 yards in width, so the "half mile or over" recommended by Dr. Guy Marshall (his reply of 7.5.26 in answer to an appeal for advice) was not easy of realisation. The Veterinary Officer, recently appointed to Maun, took out a working party of natives early in 1926 in order to improve the road along the Mogogelo River; but as the effort was tribal and the natives were not interested, very little was accomplished. In July, 1926, the Veterinary Officer (Webb, H. M.), in a communication to the Acting Chief Veterinary Officer at Palapye Road, advised (*a*) the organized destruction of game around the Xusa fly-belt and (*b*) the opening of a road direct from the Mogogelo River to Kazungula via Leshuma with 3 or 4 wells en route. The Authorities, however, decided (reply of 22.9.26), as game destruction had not been accepted as a practical and inexpensive means of fly riddance, and as the expense in sinking wells would be considerable, that it would be better to widen the existing route.

Just about this time([15]) the attention of the Imperial Government was drawn to the report of an interview given by Dr. A. L. du Toit, leader of the Kalahari Survey Party (which had recently returned from Ngamiland), to the *Star* newspaper of Johannesburg. He had referred "to the gradual extension of the tsetse fly belt into the Kalahari" and in response for further information submitted (12.3.26) a sketch-map with details which have been incorporated in Map D. These include particulars bearing on the Chobe Fly Area, especially an extension along the Savuti Channel. The Report of the Kalahari Reconnaissance of 1925 (No. 3404 of 5.5.26, Dept. of Irrigation, Pretoria), on p. 45, states "that this pest (Glossina) exists along the upper and mid-Savuti, and that a few individuals are on occasions to be caught in the neighbourhood of the Gubatsa Hills". Also to be mentioned during the last year of this period are encroachments along the southern (Ngaraga region) and western limits (towards the Taoge River), and farther extension south of Mababe also observed by du Toit.

([15]) In 1924 the Union Government Kalahari Locust Expedition reported vaguely "that a very large area in the Mbabe Flats region, 80 miles or so north of Lake Ngami, was infested with Tsetse". (*Jl. Dept. Agr., Union of S.A.*, X., p. 9, 1925.)

During the final period of this survey, i.e. *from 1926-1931*, the *Chobe Fly Area* will be described first and then the Okovango.

Until 10.11.30, when Webb, the Government Veterinary Officer, and the writer went to Sanazambo Pan, 8 miles south of Sici (Chief Sinjara), no veterinarian had ever visited the Chobe Fly Area. Sici is a village situated approximately a mile from the Chobe River on the northern edge of the bush country. As the grass had been burnt, it was decided to travel as far south as possible by motor lorry. For the first 4 miles the trees, arranged mainly in park fashion, were predominantly *Acacia* spp., then the sandveld proper with its mopani (*Copaifera mopani*) and mogonono (*Terminalia* sp.) was reached. At 7 miles the sand, being very dry, proved too heavy for the lorry, and we walked the remaining mile to the Pan, which was reached at 9 a.m. Here, in spite of a strong breeze from the east, dozens of *G. morsitans* were caught. The Chobe at this point was about one-third mile distant, and as we left the leafless mopani for the dense stream-bank vegetation, tsetse became more abundant. It was evident that game was plentiful, especially wart-hog and impala, and at 2.45 p.m. a hippo was heard in the river. Thereafter we returned to the camp at Sici, only a preliminary excursion being possible, since Dr. Hale Carpenter was awaiting the writer at Maun.

It having been decided that the Government Veterinary Officer should revisit the area in order to ascertain (*a*) whether the Chobe and Okovango Fly Areas were still separate, and (*b*) how far west the Chobe Fly Area extended, Webb returned to Sici early in December and travelled south almost as far as the Savuti River, following the right bank of the Chobe all the way. Owing to the heavy rains he was compelled to return, as otherwise the motor lorry, left at Sanazambo Pan, would have been too heavy for the marsh country between Sici and Kachikau. Webb's notes on this trip are as follows:—" Found tsetse in mopani, where lorry got stuck (i.e. 7 miles from Sici). Tsetse very numerous along river, especially near Savuti, where they came out in the open ' melapo " or flood-channels, 100 or more yards away and attacked us. Along river small sand ridge covered with large trees, Apiesboom (*Acacia* sp), Makoba (*Acacia pallens*) and other thorn trees, with palms (*Hyphaena crinita* and *Phoenix reclinata*) and thick undergrowth. Further back from river first patches of mogonono (*Terminalia* sp.) always in heavy sand and then mopani.

" At Kazezo (about 12 miles from Sici), where there are old lands of former village, there are big camel thorn trees (*Acacia giraffae*), then mogonono till near Samati's old village (about 16 miles from Sici). This is situated in mopani, which is fairly open. Beyond Samati's the dominant forest is mopani with patches of mogonono and thorn trees. Country on south bank of river higher than on north bank, which is subject to flooding. Swamp country, away from actual river bed, now dry.

" Game paths which are numerous all the way all seem to lead towards Mababe Flats. About Savuti elephant appears to be numerous from spoor.

"As one gets away from the river, tsetse gets appreciably less, and in one place none were to be seen. It looks as if there is a narrow belt along the river and that it is not more than 10 miles wide as the map (Stigand 1923) shows it.

"It will be difficult to get natives to guide one in a southerly direction to Kwaai . . . The path to Kabamakoni goes along the river to the Makwegana and then follows it. Natives going to Kwaai would go via Makarani and Mababe.

"Came back (i.e. to Sici) some distance from the river at times, mopani all the way, patches of mogouono here and there. Numerous small pans; some had water on the return journey."

It is thus evident that the object for which the above journey was undertaken was not accomplished owing to the onset of the wet season. It was now clear that the best time would be after the rains (as soon as the marshes between Kachikau and Sici had dried sufficiently for motor traffic), when not only would the forest still be in full leaf but the pans also contain water.

Another trip was made to the Chobe Fly Area by Webb and the writer at the beginning of February, 1931. The object was to test the efficiency of the Harris Fly-Trap, which the Chief Veterinary Officer (Chase, W. H.) had kindly procured at the writer's suggestion. The country about Kachikau was exceedingly dry, but as Sici was approached (between Parakarunga and Sici), it was obvious that a heavy storm would render the track impassable. We left Kachikau on 2.2.31, and reached the camp near Sanazambo Pan via Sici (30 miles) in 5 hours by motor lorry. Again Glossina was caught 7 miles from Sici although the country had undergone a transformation since the writer's previous visit in November. The grass was now green and tall, mostly in flower, the pans contained water, and the forest was in full foliage. The Chobe, however, appeared no different than before, indicating that the wet season was poor not ony in Ngamiland but also in Angola.

After a stay of 4 days it was obvious that, owing to rains between the camp and Kachikau, another retreat would have to be made owing to the nature of the country. We accordingly departed on 6.2.31 and slept at Sici. A tsetse was captured at 6 p.m. at the camp, but it is probable this was brought north from Sanazambo by the motor lorry. The result of the investigations will be given later, but it should be remarked here that whereas in November game was abundant, on this occasion none was seen, although the hoof prints of impala and wart-hog were frequent.

During February and March, 1931, Webb made a tour along the Kachikau-Puluhelo Road (Riley's Road) but encountered no fly, not even during a trip to Kanku Hill, which he reached by travelling along the old wagon road from near Sisuma Pan.

It might thus appear that tsetse at the present time is not encroaching, especially in the northern part of the Mababe Depression. It is, however, dangerous to generalize from a hurried visit. What is wanted is careful investigation.

With regard to the *Okovango Fly Area*, the position during the period 1926-1931 may be summed up as follows:—Webb, on his return from investigating pleuro-pneumonia in the Caprivi Strip at the end of 1926, visited in January, 1927, Kabamakoni, where fly were caught by his companion, Sergt. Lamb, " Within a couple of miles of some of the cattle posts ". It was clear that considerable encroachment had occurred in this region during recent years.

In the winter of 1928 the Imperial Secretary (Capt. Clifford) undertook a journey by motor lorry across the Kalahari Desert from Mahalapye to Ghanzi. From there he travelled to Maun " to discover a route from Ngamiland to the Zambesi along which cattle might travel without encountering the tsetse fly . . .". At Maun were held important interviews with the Resident Magistrate and Mathibi, the Chief of the Batawana, which should be productive of good results in respect of suppression of the tsetse . . .". In May of this year it was reported that fly had been seen 3 miles north of Maun along the Thamalakane, but it is doubtful whether such was the case. The nearest Glossina area is along the Boro River and it is generally accepted that no encroachment has taken place in this region since 1916.

As a result of the Imperial Secretary's visit the following recommendation was made (High Commissioner's Minute 1499 of 11.8.28, Pretoria), viz.: That a buffer zone free of game and cattle be formed between the Glossina and non-Glossina areas([16]).

With regard to the cattle export trade, a track was cut early in 1928 from Puluhelo east of the Xusa fly-belt to join the old road to Kazungula about 10 miles south of Tsotsoroga. This task was undertaken by Messrs. Susman Bros., of Livingstone, and so far has proved free from fly, although in December, 1930, it was reported Glossina had been encountered 25 miles north of Sakobs Well. Both Dr. Hale Carpenter and the writer, who travelled along this track in January, 1931, were of the opinion that *Haematopota* sp. and not *Glossina morsitans* had been seen. This path with little labour could be made into a serviceable motor road, thus avoiding entirely the Xusa fly-belt with its dangers([17]).

In 1929, although the export trade was in a satisfactory state owing to the use of the new cattle route, yet there was no improvement in the fly position generally. In fact, so serious was the menace that when the Governor-General (Earl of Athlone) visited Kwaai in September, 1929, he was met by Messrs. Norwebb and Deaconos (on behalf of the traders), who explained the seriousness of the position. Just prior to this, however, Dr. Guy Marshall, who attended the 6th Pan African Veterinary Conference at Pretoria in August, 1929, had been instructed by the Secretary of State for the Colonies to discuss the Glossina situation in Ngamiland with the Imperial representative

([16]) This has again been considered in the report of the writer addressed to the Chief Veterinary Officer, Mafeking, and dated 19th March, 1931.

([17]) In 1925 and 1928 the O.C. Police and Magistrate, respectively, travelled by boat from Maun to Andara and back *via* the Boro River, i.e. through the heart of the Okovango Fly Area. Their experiences as far as Glossina is concerned are not known.

in Pretoria (High Commissioner). Later, Marshall, considering that Dr. Hale Carpenter of the Uganda Medical Service (Sleeping Sickness Operations) would be the most suitable scientist to investigate, suggested that Carpenter should call at Pretoria on his way to England at the end of 1929. This he did, and in the middle of 1930 he was appointed to investigate the fly position in Ngamiland([18]). The Chief Veterinary Officer (Chase, W. H.) Bechuanaland Protectorate, however, preferred that a veterinarian should also be appointed since the problem was essentially one affecting cattle. The writer was accordingly seconded from the Union of South Africa service and from November, 1930, was in Ngamiland with Dr. Hale Carpenter, the expenses for this Glossina Commission being paid from the Colonial Development Fund.

It should be mentioned that in the winter of 1930 the Vernay-Lang Museum Expedition, after hunting in the Kalahari Desert, proceeded north to the Victoria Falls via Maun and the Mababe Flats. At Tsotsoroga at the end of June, Mr. G. van Son, the entomologist, caught a tsetse, the insect in his opinion having accompanied his motor lorry from Mababe. Since subsequent search has been negative, it would appear that the fly was a stray.

In concluding, it should be added that at the end of 1930 Carpenter and the writer circumambulated the Okovango Fly Area, and early in 1931 they travelled from Maun to Kazungula via the Cattle Road. (See Map D.) Also that in January, 1931, the Stock Inspector at Maun, R. Hoyle, travelled from Tsau east via Matsabelo to Ngaraga Pool and in February-March, 1931, Webb journeyed along the eastern side of the Okovango Fly Area, following the motor roads, but neither of these officials encountered fly. It is obvious that no deduction can be drawn from such hurried visits, except that to state whether fly was seen or not.

To summarize, it may be stated that, with regard to the Chobe Fly Area, the only information available since 1908 is that furnished in Stigand's map of 1923, the Report of the Kalahari Reconnaissance published in 1926 and the information contained in this Report. The remainder of the records mentioned above refer to the Okovango Fly Area which has received a great deal of attention in recent years, especially during 1930 and 1931.

ACKNOWLEDGMENT.

Opportunity is taken here of thanking all who assisted during my period of secondment, especially Dr. C. Brain and Mr. Rupert Jack, of Salisbury; Hon. Capt. John Smith, Mr. L. W. G. Eccles and Mr. E. Whindus, of Livingstone; Mr. R. MacDonald, of Mazabuka; and Mr. A. D. Lewis, Dr. Pole-Evans, Mr. C. Stewart and Dr. P. J. du Toit, of Pretoria. Capt. H. M. Webb, of Kazungula, Capt. R. Beeching and Mr. A. Rutherford, of Kasane, Sergt. von Hirschberg and Mr. R. Hoyle, of Maun, and Mr. Craggs, of Pretoria, all did their utmost to make my tour a success. Last, but not least, the helpful attitude of the authorities of the Bechuanaland Protectorate Government at Mafeking was most stimulating.

([18]) It was hoped that Southern Rhodesia and the Union of South Africa would participate in the investigations.

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APPENDICES.

1. *The Harris Fly-Trap.*

Since Harris had reported excellent results with *G. pallidipes* in Zululand with the trap and decoy devised by him and demonstrated to the representatives of several Administrations in November, 1930, it was decided to test its efficiency for *G. morsitans*. A trap was accordingly employed at Sanazambo Pan near the Chobe River (and about 30 miles from Kachikau) early in February, 1931.

The fly density was approximately that noted by the writer on several occasions in the Umfolosi ex-Game Reserve, Zululand, in 1921 and 1922. A general idea of the topography may be gained by a glance at Fig. 1 showing the large light grass patch representing the Pan. Almost surrounding it is mopani, while along the Chobe River is dense forest chiefly of evergreen type. The view is taken from the mosaic prepared by the South African Air Force in 1925 for the Kalahari Reconnaissance Party. The trap was placed according to the instructions of Harris (see 3, Fig. 1), and at 6.30 a.m., 4.2.31, i.e. after 22½ hours in position, the following were counted:—19 *G. morsitans* (13 female, of which 4 were gravid, and 6 males), 24 Tabanids, 4 Stomoxys, 2 moths and 1 ant. The trap, which had been placed at the south end of the Pan, was then removed to the south bank of the Chobe River (see 4, Fig. 1) and 24 hours later, i.e. 7 a.m. on 5.2.31, it was found to contain 2 Glossina (both males) 9 Tabanids, 33 Stomoxys, and 12 miscellaneous, including moths and mosquitoes. On this morning at 8 a.m. the trap was removed to a point near the original site (see 5, Fig. 1) but well in the mopani bush. At 6 a.m. on 6.2.31, i.e. 22 hours later, there had been captured 4 Glossina (3 males and 1 female) and 7 Tabanids. Up to now weather conditions had been perfect. The trap was allowed to remain in the same position until 1 p.m., but the morning being dull, nothing was caught. Owing to the inclemency of the weather it was necessary to break camp in the afternoon, and the next morning the swampy area was crossed with some difficulty.

With even limited experience of the trap, it is obvious certain modifications would prove more effective. In fact these were introduced in several decoys and traps made of sacking, mopani poles, paraffin cases and ordinary mosquito netting. It was considered that the sloping sides of the Harris trap with its absence of " legs " and small ventral opening were disadvantageous, so on the 5.2.31 a modification was made introducing the points hinted at above. This decoy plus trap was placed near the Harris fly-trap at 8 a.m., 5.2.31, and 22 hours later was found to contain 2 Glossina (one male and one female), 9 Tabanids, 2 Sarcophaga and 10 Stomoxys, totalling 23 flies, whereas the Harris trap only contained 11, including 2 Glossina.

Harris (1930) in his instructions states (p. 5) that " no supervision is required ", but this is essential. He further makes no reference as to how flies should be removed from the trap since the removal of the large lid would allow many specimens to escape. Obviously where it was desired to transfer flies to other receptacles, some modification of the lid is necessary. Several methods are possible. Since not transfer but death of the captured flies was our aim, we found it easiest to merely spray the trap (containing the imprisoned flies) with " Komo " or " Flit ". Finally, with regard to the cost of the improvised decoy and trap combination, we found a few shillings would cover all expenses.

As Harris rightly remarks, " a very vast amount of experimental work still remains to be done " (p. 1), but it is clear he is proceeding on right lines and his trap (or modifications) will undoubtedly decimate Glossina([19]). A claim, however, that it will rid the country of tsetse is hardly practicable, for there will always remain the last few flies which evade capture, but which are sufficient in number to lead to Nagana outbreaks, as experience in Zululand (Ntambanana) has shown. In short, then, the Harris trap will prove a valuable measure of control (*for G. pallidipes*) but will not lead to the eradication of the pest. A point to be emphasized is that, whereas Harris is dealing with *G. pallidipes* in Zululand, the observations recorded above refer to *G. morsitans.*

2. *Other Biting Arthropods.*

The most troublesome mosquito, especially at Kurube and along the Chobe River, was *Taeniorhyncus africanus.*

The biting flies captured up to the end of January (i.e. prior to Dr. Hale Carpenter's departure) were handed to Dr. Hale Carpenter. Subsequent to this, the following species were caught at Sanazambo, Chobe River:—

Tabanus biguttatus.
,, *croceus.*
,, *gratus.*
,, *fuscipes.*
,, *par.*
,, *taeniola.*
,, *ditaeniatus.*
Stomoxys nigra.
Haematopota decora.
,, sp.
Hippobosca rufipes.

When compared with Zululand, where the writer investigated Nagana in 1921-23, ticks were few in number. The commonest species was *Hyalomma aegyptium* both on the ox and horse.

Rhipicephalus simus, R. evertsi and *R. evertsi mimeticus* were, however, observed, infecting more frequently the former host.

Haemaphysalis leachii was the common dog-tick; and frequently to be seen on tortoises was *Amblyomma marmoreum.*

([19]) The fear expressed by a Zululand delegate at the 1931 Conference of the Natal Agricultural Union, viz., that the placing of traps in the game reserves would drive the game on to the adjoining farms, could be surmounted by prudence in supervision. See *Farmer's Weekly*, 6th May, 1931, p. 595.

ADDENDUM.

Since writing the above, Mr. Rupert Jack has kindly commented (letter 26.10.31) on the paper, the following being a résumé of his remarks:—

(*a*) Additional data have been obtained by him regarding the pre-Rinderpest distribution of Glossina in Southern Rhodesia;

(*b*) He seeks an explanation for the apparent huge fly-free gap between Lake Ngami and the Limpopo Basin during the past century; and

(*c*) He refers to experiments with fly-traps.

Regarding (*b*), the sole reason for showing an extensive fly-free area in Map A (between Lake Ngami and the Limpopo Basin) is the absence of definite information. Neither Livingstone nor the Boers of the "Dorsland Trek" encountered fly until near Lake Ngami. Although vast areas, e.g. east of the Okovango Delta, are unsuitable for tsetse on account of the *low* scrub, yet there are other regions where apparently there would be sufficient cover.

Fig. 1.—Aerial view of Chobe River near Sanazambo Pan, which shows as a conspicuous light (grassy) patch close to the bend of the river. (S.A.A.F. photo lent by Director of Irrigation, Pretoria.)

Fig. 2.—View of bend of river referred to in Fig. 1. Note dense stream-bank bush on right bank and reeds on left bank, which is subject to flooding. 10th February, 1931.

Fig. 3.—Sanazambo Pan during the dry season. It contains no water and the grass has been burnt. Note baobab tree (×) and game-path leading to Chobe River. 10th November, 1930.

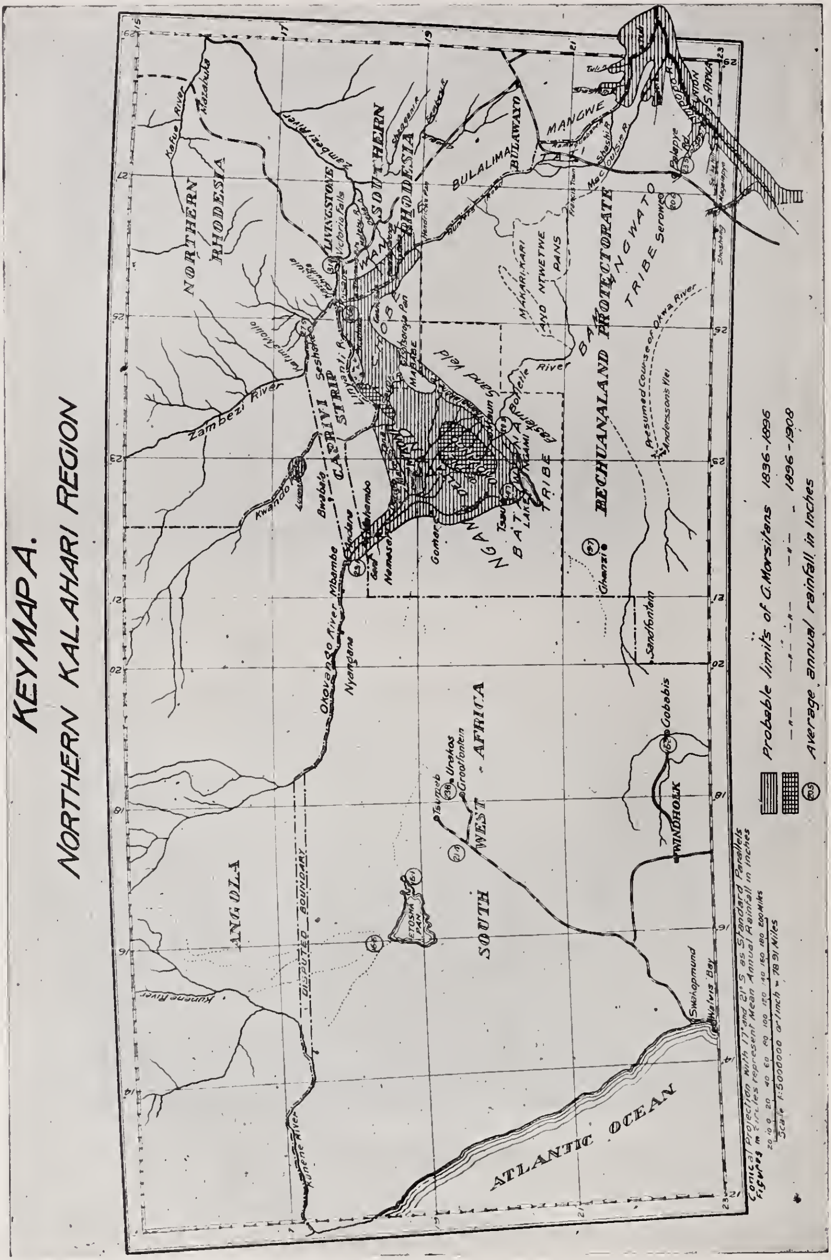
Fig. 4.—Sanazambo Pan during the wet season. It contains water and the grass is waist-high. Note baobab tree (×) and mopani in full leaf. 5th February, 1931.

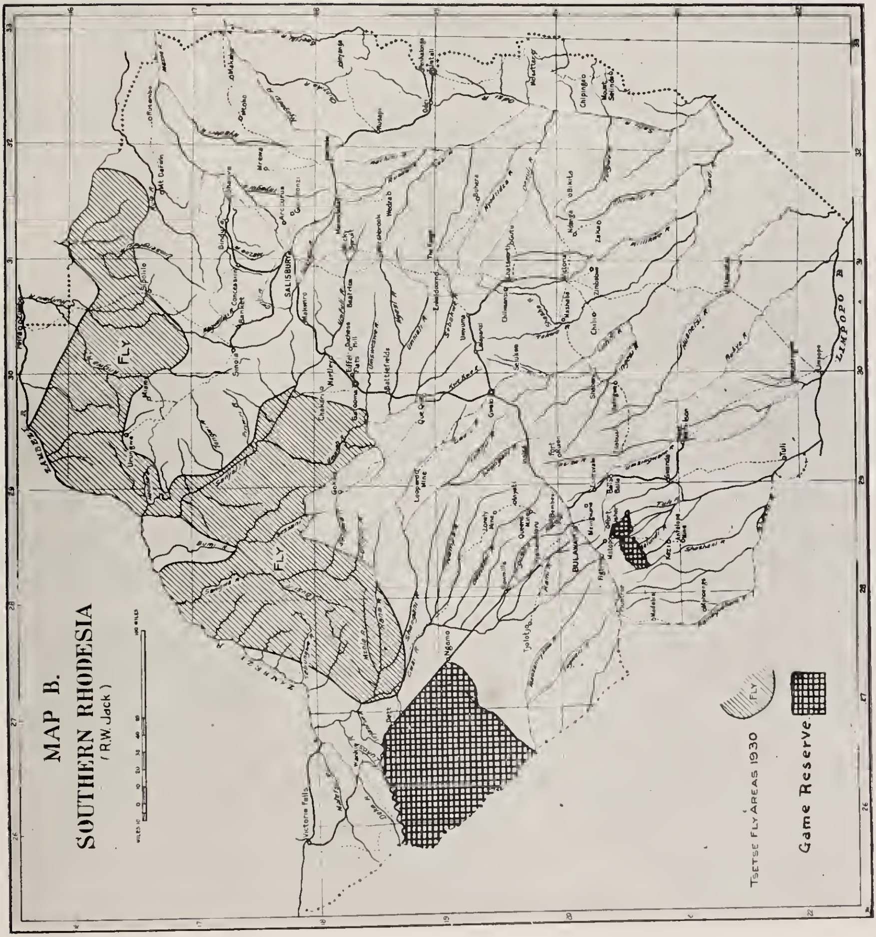
Fig. 5.—The Okovango River (300 yards wide) at Mahembo, North Ngamiland.

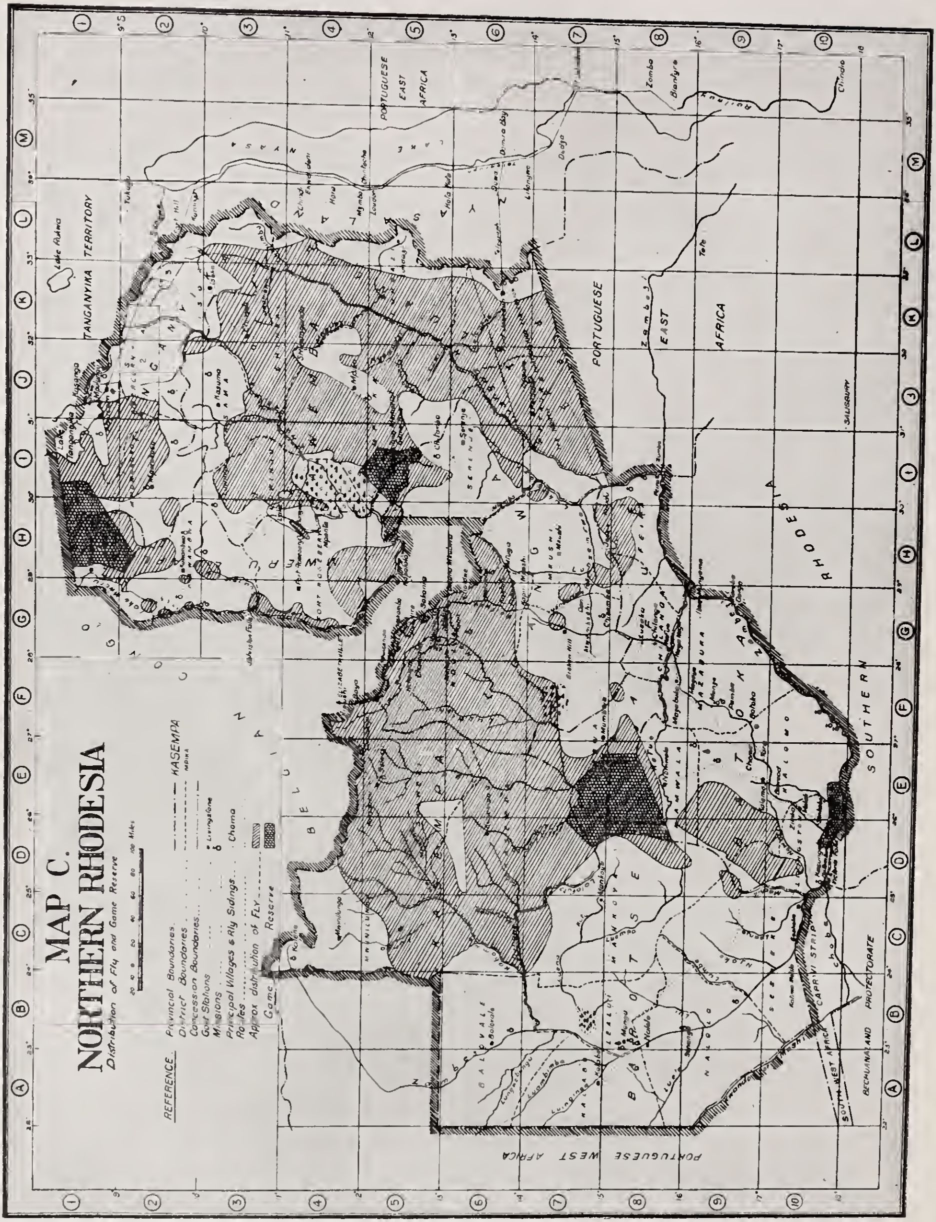
Fig. 6.—In Central Ngamiland the Okovango River forms a delta, and its waters meet again in the Thamalakane River. The view, showing cattle grazing along the Thamalakane River, a few miles north of Maun, was taken on 14th November, 1930. Note overgrazing of pasture and dense evergreen fringing bush.

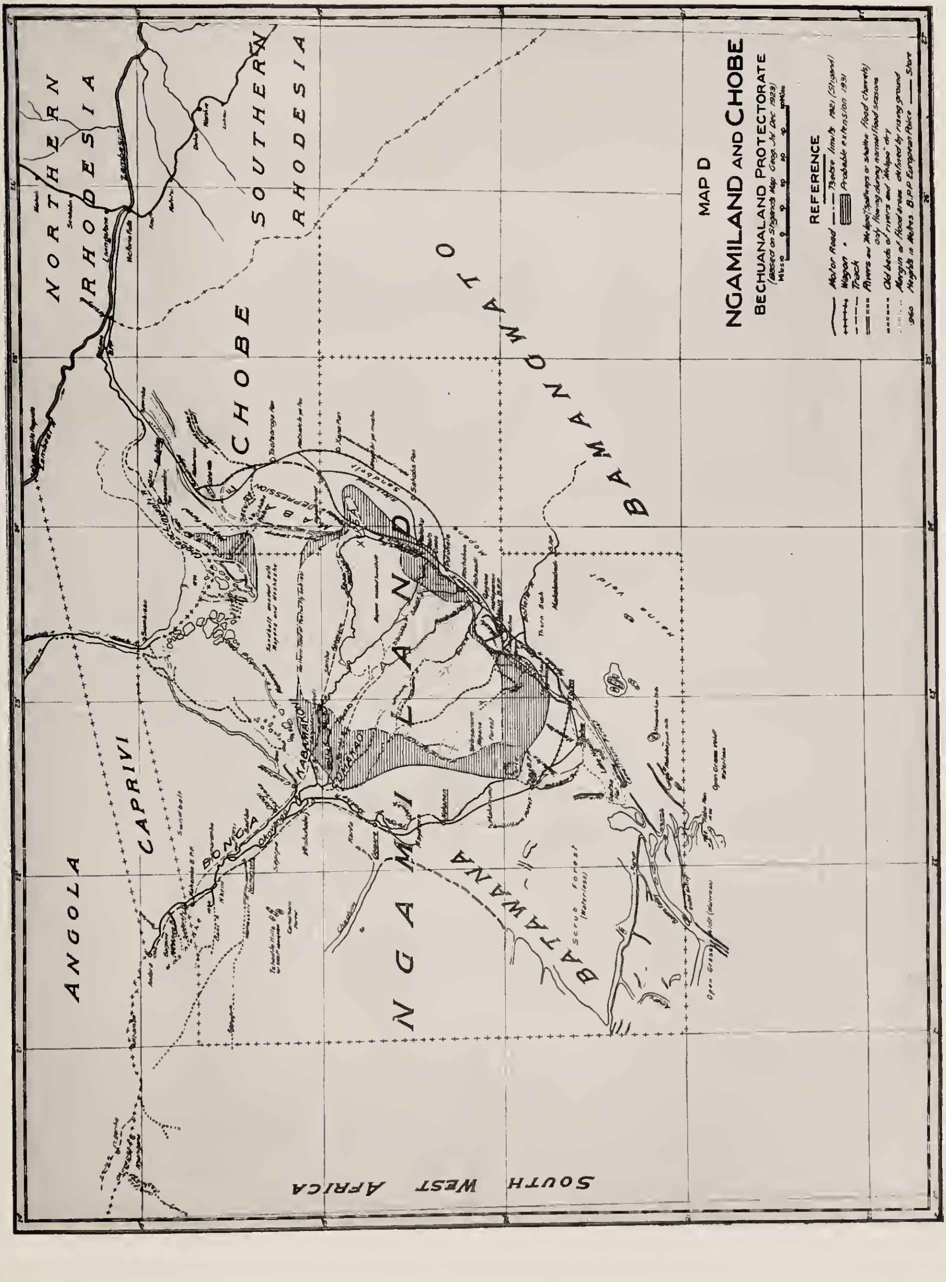
Fig. 7.—Improvised modification of Harris Fly-trap, Sanazambo Pan, February, 1931.

Fig. 8.—Country west of Kachikau flooded during the wet season. Note the "islands" of bush which, with continuing desiccation, become linked up, *Acacia* spp. being a prominent pioneer. 6th February, 1931.


KEY MAP A.
NORTHERN KALAHARI REGION
NORTHERN RHODESIA
SOUTHERN RHODESIA
ANGOLA
SOUTH WEST AFRICA
BECHUANALAND PROTECTORATE
CAPRIVI STRIP
ATLANTIC OCEAN
Zambezi River
Okovango River
Kunene River
Kafue River
LIVINGSTONE
Victoria Falls
BULAWAYO
MANGWE
BULALIMA
MAKARIKARI AND NTWETWE PANS
NGWATO TRIBE
Serowe
BATAWANA TRIBE
LAKE NGAMI
Botletle River
Presumed Course of Okwa River
Anderssons Vlei
Ghanzi
Sandfontein
Gobobis
WINDHOEK
Swakopmund
Walvis Bay
ETOSHA PAN
Tsumeb
Uraskos
Grootfontein
Nyangana
Kwando
Mababe
DISPUTED BOUNDARY
Probable limits of G. Morsitans 1836-1896
1896-1908
Average annual rainfall in inches
Conical Projection with 17° and 21° S as Standard Parallels
Figures in circles represent Mean Annual Rainfall in inches
Scale 1:5000000 or 1 inch = 78.91 Miles


MAP B.
SOUTHERN RHODESIA
(R.W. Jack)
Tsetse Fly Areas 1930
Game Reserve
FLY
FLY
SALISBURY
BULAWAYO
LIMPOPO R
Victoria Falls


MAP C.
NORTHERN RHODESIA
Distribution of Fly and Game Reserve
REFERENCE.
Provincial Boundaries
District Boundaries
Concession Boundaries
Govt Stations
Missions
Principal Villages & Rly Sidings
Roads
Approx distribution of FLY
Game Reserve
KASEMPA
Livingstone
Choma
TANGANYIKA TERRITORY
PORTUGUESE EAST AFRICA
PORTUGUESE EAST AFRICA
SOUTHERN RHODESIA
PORTUGUESE WEST AFRICA
BECHUANALAND PROTECTORATE
SOUTH WEST AFRICA
CAPRIVI STRIP
SALISBURY


MAP D
NGAMILAND AND CHOBE
BECHUANALAND PROTECTORATE
REFERENCE
NORTHERN RHODESIA
SOUTHERN RHODESIA
ANGOLA
CAPRIVI
CHOBE
NGAMILAND
BATAWANA
BAMANGWATO
SOUTH WEST AFRICA

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

Description of *Argas striatus*, a New Species of Tick.

By G. A. H. BEDFORD, Research Officer, Onderstepoort.

ARGAS STRIATUS nov. sp.

THE following description is based upon three unfed females found in the nest of a sociable weaver, *Philetairus socius* (Lath.) at Kenhardt, C.P. They were sent by Dr. R. F. Lawrence for identification. The holotype and one paratype will be deposited in the South African Museum, Capetown, and the other paratype in the Onderstepoort collection.

Female.

Body long and narrow, 6 by 3·5 mm., the anterior margin tapering to a rounded point, the sides parallel, and the posterior margin rounded. Margin transversally striated and raised higher than the rest of the integument in unfed specimens; brown in colour and paler than the rest of the body, which is dark brown and sparsely clothed with short, pale setae. *Dorsum* striated, the enclosed areas between the striae small and irregular in shape; on the anterior and median portions of the body they are flat and smooth, and behind raised, making the surface appear wrinkled; in the middle a semi-circular row of four shallow discs, a median one beneath them, and a small pair in front; grooves present, indistinct. *Venter* wrinkled, without discs; genital orifice situated between coxae i; median postanal groove long and very shallow; a deep groove extends on each side from coxae iv almost to the posterior margin, the inner margin being raised higher than the rest of the integument. *Hypostome* with minute teeth anteriorly, followed by dentition 2/2.

Legs yellowish; coxa i separated from coxa ii; coxa ii, iii and iv contiguous; tarsi without protuberances.

This species is apparently closely related to *Argas aequalis* (Neumann), which was described from a single late-state nymph collected in Tanganyika Territory. The host is unknown. As Neumann did not figure the species, and his description is somewhat short, it is difficult to compare it with the specimens described above, but in *aequalis* the integument is folded, with very fine granulations.

Argas striatus.

As sociable weavers occupy the same nests year after year it is possible that *A. striatus* may be a temporary feeder, remaining in the nests and hibernating during the periods the nests are not occupied by the birds. The South African cliff swallow (*Petrochelidon spilodera*) is another bird which uses the same nest year after year, and *A. pérengueyi* (Bedford and Hewitt), which is parasitic on this species, hibernates in the nest during the winter months.

Fig. 1. *Argas striatus* nov. sp., dorsum of female.

Fig. 2. *Argas striatus* nov. sp., venter of female.

18th Report of the Director of Veterinary Services and Animal Industry, Union of South Africa, August, 1932.

A Synoptic Check-List and Host-List of the Ectoparasites found on South African Mammalia, Aves, and Reptilia.
(Second Edition.)

By G. A. H. BEDFORD, Research Officer, Onderstepoort.

INDEX.

INTRODUCTION.

Since the first edition appeared in Part I of the 11th and 12th Reports of the Director of Veterinary Education and Research, 1927, not only have a number of new species of ectoparasites been described and numerous known species recorded from fresh hosts, but many important changes have been made in the classifications of these Arthropods. Moreover, when the first edition was in the Press the writer was absent in England, with the result that a large number of errors are to be found therein. It has therefore been considered advisable to publish a second edition, and it is to be hoped that in this edition errors will be conspicuous by their absence.

In the introduction to the first edition it was pointed out that the check and host lists were very far from being complete. There are undoubtedly a vast number of species still waiting to be discovered, and a great deal of collecting will have to be undertaken before our knowledge of the ectoparasites can be considered anything like complete.

As an incentive to collecting and increasing our knowledge of these parasites, brief notes on how to collect, preserve and mount them have been included in this edition.

To Professor Cooley the author is indebted for a list of the ticks, together with their hosts, that were collected by him in South Africa. These were identified by Mr. Warburton. The author is also indebted to both Dr. Ingram and Mr. De Meillon for unpublished records of the fleas in the collection of the South African Institute for Medical Research, Johannesburg.

INTRODUCTION TO FIRST EDITION.

Before commencing to write this paper, it was realized only too fully that any check list or host list of the external parasites occurring on South African mammals, birds, and reptiles written at the present time would be very far from being complete. It was, however, considered advisable to place on record our present knowledge of these parasites, not only with a view to bringing it up to date as far as possible, but also to encourage the collection of parasites by zoologists, ornithologists, and others, who periodically have grand opportunities of obtaining material. Every year the country is being thrown open more extensively to settlers, and, as civilization advances, wild animals and birds decrease in numbers. It is quite possible that within a short period some of our mammals and birds may become extinct—if not altogether, certainly in some districts—and it would be very interesting and important to have a knowledge of the parasites before their hosts disappear, and they with them.

The distribution of a permanent parasite, i.e. a parasite which is entirely dependent upon its host for its existence, such as a bird-louse or parasitic mite, usually coincides with the distribution of its host, or may, if it possesses more than one host, as is frequently the case, overlap it. For instance, both the bird-louse (*Esthiopterum struthionis*) and the feather mite (*Pterolichus bicaudatus*) of the South African ostrich have also been found on the American ostrich

(*Rhea americana*), and the former has also been recorded from the North African ostrich (*Struthio camelus*). On the other hand, parasites, such as ticks, fleas, and some parasitic mites which do not live the whole of their existence on their hosts, are usually restricted in their range, owing to climatic conditions, unfavourable breeding grounds, etc. Temporary parasites are, as a rule, less particular in the selection of their hosts than permanent parasites, and many of them may be found on a number of animals which are in no way related to each other. Therefore, the distribution of a temporary parasite may also overlap the distribution of some of its hosts.

In this paper I have not hesitated to include all permanent parasites found on migratory birds, irrespective of whether the parasites were collected in this country or not, except that American records have not been included,* because, as a rule, most birds migrate from north to south or vice versa. In every instance where the parasite has been collected in this country the locality has been given. On the other hand, only temporary parasites have been included when they have been actually found or recorded as taken in South Africa.

TECHNIQUE.

Collecting.

Some species of ectoparasites may be found on any part of their host's body, whereas others confine themselves to certain parts. Small parasites are best collected either with a pair of fine forceps or a camel's hair brush that has been dipped in ether or alcohol.

Numerous species have been recorded from hosts upon which they could not live, and these records are mainly due to the fact that the parasites had been allowed to wander from their true hosts on to foreign hosts, either in collecting bags or on the skinning tables. When a small mammal or bird is therefore trapped or shot, it should be immediately placed in a white linen bag and the opening tightly tied with string, or wrapped up in paper so that the parasites cannot escape. The best way to collect fleas and mites from a small mammal is to sprinkle a few drops of ether on it. Hippoboscid flies parasitic upon birds should be collected in the same way as they are very active and leave their hosts almost immediately the birds are killed.

Fleas and other parasites may also be bred from the nests of small mammals and birds. The nests should be kept either in glass jars with a piece of paper tied over the opening, or in glass-topped boxes lined with white paper. The name of the mammal or bird should be recorded on a label stuck on the jar or box. Nests of birds should be taken immediately after the young have flown. Fleas may continue hatching up to two months after the nests have been collected. They may be collected off the sides of the jar or box with a camel's hair brush dipped in ether. The nests should be slightly damped occasionally with water. Lice may also be collected from skins of mammals and birds in museums.

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* Other than parasites found on seabirds.

Preserving.

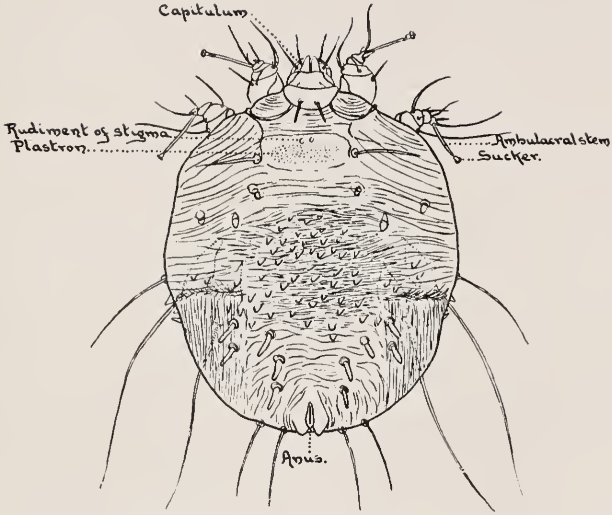
All ectoparasites, including the winged Hippoboscidae (except *Hippobosca*) and Streblidae, should be preserved in 70 per cent. alcohol, and the name of the host, locality and date written on a piece of paper in pencil and placed in the tube along with the parasites.

To preserve ticks in their natural colours, the following formula recommended by Mönnig (*Rep. Dir. Vet. Serv. and Anim. Indust.*, XVI, pp. 199-200, 1930) may be used:—A solution of 4 per cent. formaldehyde (10 per cent. commercial formalin) is placed in a tube, a few drops of chloroform added and the tube shaken. If all the chloroform dissolves more is added and the shaking repeated until the solution is saturated. If an excess of chloroform is present, the solution is poured off from it. The live ticks should be dropped into this and the tube firmly stoppered and made air-tight. The tubes should not be opened for three months. If an excess of chloroform is used the ticks become paler, and if there is too little chloroform they turn darker.

Mounting.

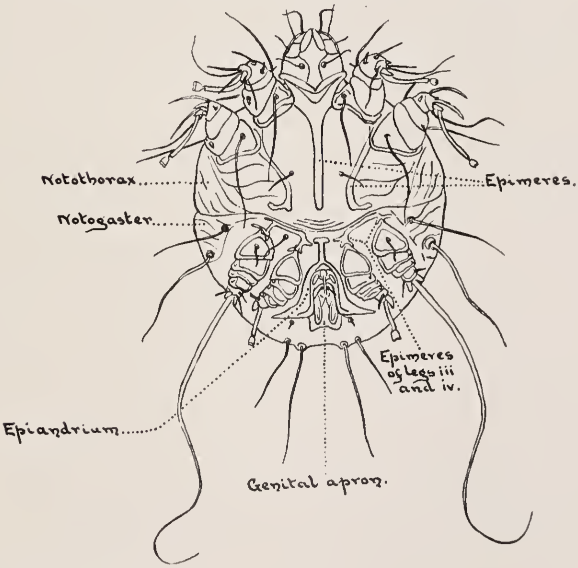
To prepare lice for mounting, first heat them in a 10 per cent. solution of caustic potash. Small specimens should be heated for about 10 minutes, and large specimens, such as *Laemobothrion*, about 20 minutes. This is best done by placing them in a small glass tube containing the caustic potash, and placing this in a metal container, containing water and a little cotton wool to prevent the tube from falling over, over a bunsen burner. After heating transfer the specimens to water. When in the water the specimens should be pricked with a fine entomological pin, and then very gently pressed with the head of a pin to expel the contents that have not been dissolved by the potash. After washing for 15 minutes transfer to 70 per cent. alcohol for 15 minutes, then to absolute alcohol for 15 minutes, and finally to oil of cloves for 10 minutes. After removing the specimens from the oil, place them on paper (not blotting paper) to remove as much of the oil as possible. Then place each specimen, venter up, on a cover-glass that has been smeared with a thin layer of thick Canada balsam and spread out the legs and antennae with a pin. The balsam will keep the legs and antennae in position. Place the cover-glass on a slide on which has been placed some thin balsam. On no account apply pressure to the cover-glass. Finally, heat gently over a spirit lamp to remove any air bubbles that may appear, and also to harden the balsam. A label with the name of the parasite, the host, locality, date, etc., should be stuck on the slide beside the mount.

Cimicidae and Diptera Pupipara should be mounted in the same way, except that the wings of winged forms must be removed before placing the specimens in caustic potash. After immersing the wings in oil of cloves they should be mounted in balsam on the same slide as the body. To avoid distortion of the body bits of broken glass may be used to support the cover-glass.



A. B. M. Whitnall del.

Fig. 1. *Sarcoptes scabiei*, dorsum of female.



A. B. M. Whitnall del.

Fig. 2. *Sarcoptes scabiei*, venter of male.

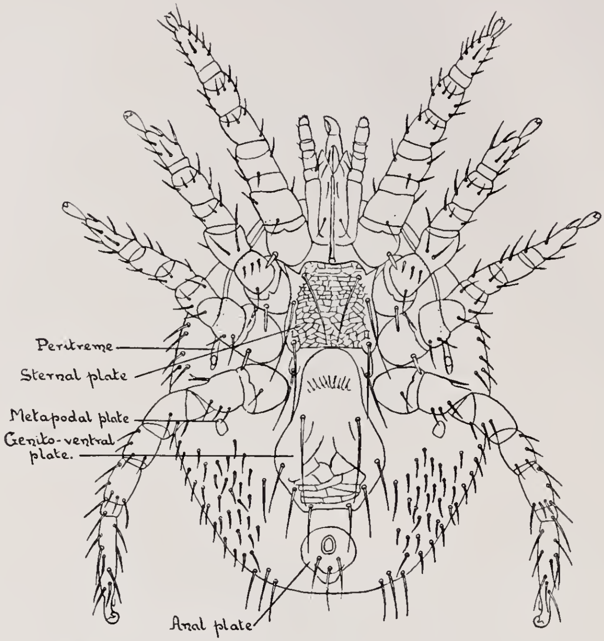


Fig. 3. *Laelaps giganteus* Berlese, venter of female.

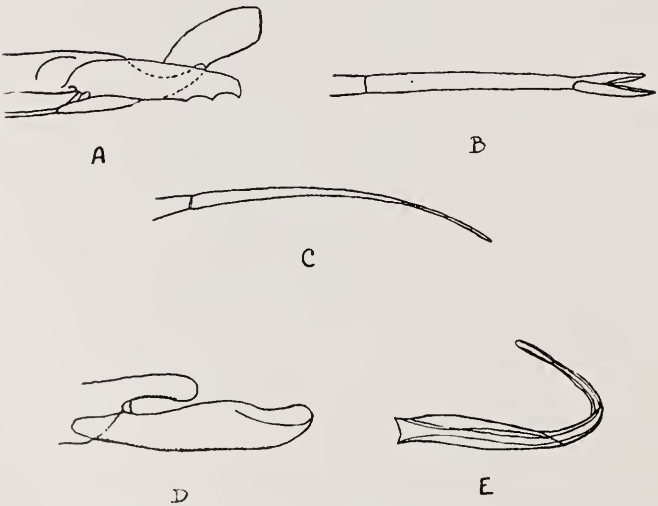


Fig. 4. Chelicerae of A, *Myonyssoides capensis*, ♀; B, *Liponyssus bacoti*, ♀; C, *Dermanyssus gallinae*, ♀; D, *Myonyssoides capensis*, ♂; E, *Laelaps muricola*, ♂ (after Hirst).

Acari may be mounted in either glycerine jelly, liquido faure or résin mastic. If either the last named media are used the specimens can be mounted direct from absolute alcohol, and no heating is required. Chitinous species may be mounted in balsam in the same way as lice.

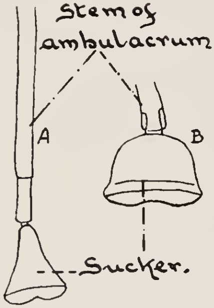


Fig. 5. Discal ends of legs of A, *Psoroptes*, and B, *Chorioptes*.

Ticks should not be mounted, except the unengorged larvae and nymphs. These may be mounted in either liquido-faure or résin mastic.

Fleas should be cleared by placing them in a glass tube containing 10 per cent. caustic potash for 19 hours. Then wash in two or three changes of water for 15 minutes; transfer to 70 per cent. alcohol for 15 minutes, then heat in carbolic acid (100 gm. carbolic acid + 10 c.c. water) for 20 minutes. Finally mount in balsam and heat very gently over a spirit lamp.

Order ACARINA.

The Acarina, which includes the mites and ticks, belongs to the class Arachnida. With the exception of the ticks, they are usually minute, and may be distinguished by their having the abdomen unsegmented and broadly united to the cephalothorax, there being frequently no suture between the two. In the superfamily Tarsonemoidea, however, many species show a body segmentation. Eyes may be present or absent. The mouth-parts are variable; they are suctorial, but frequently capable of biting and piercing. Respiration by means of tracheae or by the general surface of the body. The integument is either soft or leathery, and chitinous plates are frequently present. The legs usually terminate in suckers, hairs or claws. The larvae possess three pairs of legs, and the nymphs and adults four pairs, except in a number of adults of Tarsonemoidea one or two pairs are usually rudimentary or absent, and the plant gall mites (Eriophyidae) possess only two pairs of legs. A large number of species are parasitic upon vertebrates and invertebrates, both land and aquatic animals being attacked. Others are parasitic upon plants, and a number live on organic matter. The majority of species that are parasitic upon animals live either on or in the skins of their hosts, and a few are known to live in the

tissues and lungs. A large number of species that are parasitic upon birds live either on or in the feathers of their hosts. A few are known to be parasitic upon mammals only in their larval stage, and in their nymphal and adult stages are predaceous.

KEY TO THE SUBORDERS CONTAINING PARASITIC SPECIES.

1. Tracheae absent 2
   Tracheae present; if spiracles are absent the abdomen is usually segmented 3
2. Body not vermiform; legs composed of more than 3 joints ... ... ASTIGMATA, p. 230.
   Body vermiform; legs rudimentary, composed of only 3 joints; species parasitic in the hair follicles of mammals ... ... BRACHYPODA, p. 267.
3. Tracheae opening at or near the bases of the chelicerae; adults free living; larvae frequently parasitic PROSTIGMATA, p. 268.
   Tracheae not opening at or near the bases of the chelicerae 4
4. Spiracles absent or present, if present they vary in number and position and are situated ventrally; abdomen usually showing segmentation; females frequently with a pair of clavate sensory organs (pseudostigmata) on the cephalothorax between the first and second pairs of legs ... ... HETEROSTIGMATA
   Spiracles two in number, usually situated laterally, rarely dorsally, if the former on the sides of the body, either behind the posterior pair of legs or between the third and fourth pairs; larvae of some species have three pairs of spiracles situated laterally ... MESOSTIGMATA, p. 271.

Suborder ASTIGMATA.

Superfamily SARCOPTOIDEA.

Key to the Families (after Ewing).

1. Either maxillae or some of the legs modified into hair clasping organs. Parasitic upon mammals LISTROPHORIDAE, p. 267.
   Without any specialized apparatus for clasping the hairs of mammals. Parasitic upon mammals, birds or insects ... 2
2. Body strongly depressed; sexual dimorphism sometimes very strongly pronounced. Living among the feathers of birds ... ... ANALGESIDAE, p. 240.
   Body rarely strongly depressed; soft bodied mites. Not living in or on the feathers of birds 3
3. Parasitic exclusively on insects ... CANESTRINIIDAE
   Inhabiting the living tissues of vertebrates 4
4. Vulva longitudinal; mouth-parts fused, forming a sucking tube. Parasitic in the tissues of birds CYTOLEICHIDAE, p. 239.
   Vulva transverse; mouth-parts free. Parasitic either on or in the skins of mammals and birds ... SARCOPTIDAE, p. 231.

Family SARCOPTIDAE.

The mites included in this family are very small, whitish, and round or oval in shape. They are usually considered to be without tracheal tubes, but Hirst has recently discovered such to be present in the genus *Otodectes*. The majority of the species are parasitic upon mammals, living either on or in the skin, but a few are found on birds.

Key to the Genera.

1. Species very small; legs III and IV very short, either not projecting or hardly projecting beyond margin of body; ♂ without posterior lobes and anal suckers on abdomen ... 2

   Species larger; legs III and IV of ♀ and immature stages longer, projecting beyond margin of body; in the ♂ legs IV much shorter than legs III; ♂ with posterior lobes and anal suckers on abdomen; pubescent ♀ with copulatory knobs at apex of abdomen 4

2. Anal opening dorsal; tarsal suckers present on legs I and II of ♀, and legs I, II and IV of ♂ ... *Notoedres*, p. 231.

   Anal opening terminal, not dorsal 3

3. Tarsal suckers absent on all the legs of ♀, present on all the legs of ♂; ♀ with a pair of longitudinal chitinous bars on the dorsum in front; only a few hairs at most present on dorsum ... ... *Chemidocoptes*, p. 232.

   Tarsal suckers present only on legs I and II of ♀, and legs I, II and IV of ♂; longitudinal bars absent on dorsum of ♀; dorsum with sharp-pointed scales and rod-like setae ... ... *Sarcoptes*, p. 233.

4. Tarsal suckers borne on a short, unsegmented peduncle 5

   Tarsal suckers borne on a long, 3-segmented peduncle *Psoroptes*, p. 237.

5. Tarsal suckers present on legs I, II and IV of ♀; posterior lobes of ♂ well developed with spatulate setae on posterior margins ... ... *Chorioptes*, p. 238.

   Tarsal suckers present only on legs I and II of ♀; posterior lobes of ♂ much less salient, the hairs not spatulate *Otodectes*, p. 239.

Genus Notoedres Railliet.

Notoedres Railliet, *Zool.*, ed. 2, p. 660 (1893).

Notoedrus Canestrini, *Prosp. Acarof.*, VI, p. 724 (1894).

This genus contains two species that have been found in Europe, namely, *N. cati* on cats and also occasionally on dogs, with the variety *cuniculi* on rabbits, and *N. notoedres* on *Rattus rattus* and *R. norvegicus*. Both species are very small and burrow into the skins of their hosts.

1. **Notoedres cati cati** (Hering).

Sarcoptes cati Hering, *N. Act Ac. Leop.*, XVIII, ii, p. 605, Pl. 44, f. 9-10 (1838).

Sarcoptes minor Fürstenberg, *Krätzm.*, p. 215, Pl. VIII (1861).

Notoedres cati (Hering) Can. and Kram., *Demod. und Sarc.*, p. 11 (1899).

Notoedres cati (Hering) Oudemans, *Archiv. Néerland. Sci. Exact et Natur.* (111B), IV, pp. 147-159, p. 3-8 (1926).

This variety we found on a cat at Onderstepoort on the 20th September, 1927. It usually attacks the face and ears, but in addition to these parts the tail of the animal was also attacked.

2. **Notoedres cati cuniculi** (Gerlach).

Sarcoptes cuniculi Gerlach, *Krätze*, Pl. 3, f. 20, 21 (1857).

Sarcoptes minor var. cuniculi Railliet, *Zool.*, ed. 2, p. 66 (1895).

Notoedres cuniculi (Gerlach) Can. and Kram., *Demod. und. Sarc.*, p. 11 (1899).

Notoedres cuniculi (Gerlach) Oudemans, *Archiv. Néerland. Sci. Exact et Natur.* (111B), iv. pp. 159-164 (1926).

This variety is occasionally found on domestic rabbits in this country. It usually attacks the face, especially round the eyes, and occasionally also the ears. The legs and genital regions may also become infected in advanced cases. Hirst (1922) states that this variety is probably identical with *N. cati*, but that it is difficult to transmit *cati* to rabbits.

3. **Notoedres notoedres** (Méigen).

Sarcoptes notoedres var. muris Méigen, *Paras.*, p. 172 (1880).
Notoedrus muris Canestrini, *Prosp. Acarof.*, VI, p. 754 (1894).

This species has been found on *Rattus rattus* (black rat), Maseru, Basutoland (coll. F. A. Verney). It chiefly affects the ears, but in advanced cases the face, feet, tail and genital regions become infected.

Genus Cnemidocoptes Fürstenberg.

Cnemidocoptes Fürstenberg, *Mt. Ver. Vorpomm. und Rüg. in Greifsw.*, ii, p. 56 (1870).

Dermatoryctes Ehlers, *Zeitsch. f. wiss. Zool.*, XXIII, p. 251 (1873).
This genus contains about six species parasitic upon birds.
Genotype: *Knemidokoptes viviparus* = *Sarcoptes mutans*.

1. **Cnemidocoptes mutans** (Robin).

Sarcoptes mutans Robin, *Bull. Soc. Moscou*, XXXIII, p. 184 (1860).

Sarcoptes anacanthes Delafond and Bourg., *Mém. prés. Ac. France*, XVI, p. 291 (1862).

Knemidokoptes viviparus Fürstenberg, *Mt. Ver. Vorpomm.*, II, p. 56 (1870).

Cnemidocoptes mutans (Robin) Can. and Kram., *Demod. und Sarc.*, p. 16 (1899).

This species is parasitic upon fowls and produces symptoms known as " scaly leg "; it is a common disease in South Africa. The mites usually commence to attack their hosts beneath the scales just above the toes, and gradually work their way up the feet, causing the scales to become displaced. Occasionally the comb and neck are also attacked. This species can be distinquished from *C. gallinae* by the transverse striae on the dorsum being interrupted in the median area so as to form raised scale-like sculpturings; also there is only a single pair of long setae at the apex of the abdomen, whereas in *C. gallinae* there are three pairs of short setae in addition to the pair of long ones.

2. **Cnemidocoptes gallinae** (Railliet).

Sarcoptes laevis var. gallinae Railliet, *Bull. Soc. Zool. France*, XII, p. 132 (1887).

Cnemidocoptes gallinae (Raill.) Can. and Kram., *Demod und Sarc.*, p. 15 (1899).

This species lives embedded in the tissues or scales at the base of the quills on the body and wings of fowls, also occasionally on the neck and head, causing the feathers to fall out. This complaint is known as " depluming itch "; it is not very common in South Africa.

Genus SARCOPTES Latreille.

Sarcoptes Latreille, *Gen. Crust. Ins.*, I, p. 151 (1806).

Eusarcoptes Railliet, *Zool.*, *ed.* 2, p. 640 (1893).

The mites belonging to this genus are parasitic upon a number of animals, including the domestic animals. They burrow into the skins of their hosts, producing symptoms known as " mange ". A number of authorities regard the acari occurring on different species of animals as distinct species, whereas others, including Hirst, consider them to be varieties of a single species. We hold the latter view for the following reasons:—

The chief characters used for differentiating these acari are: the size, the presence or absence of minute setae on the bodies, and the shape of the scales on the dorsum. Size cannot be considered to be a specific character, because plants increase in size to a much greater extent when grown in some soils than in others, and it is only reasonable to expect these parasites to increase in size to a greater extent on some species of animals than on others. Moreover, it is necessary to clear and mount these small acari before examining them, and although no pressure should be applied to the cover mounts, the mount alone may change the shape and size of various parts. The short setae on the bodies may vary in number and may eventually prove to be specific characters, but as they are very fragile and minute they may be either easily rubbed off or overlooked,

especially if the specimens are not properly cleared. Ticks are much larger and more highly chitinized than these small mites, but it is remarkable to what extent various drawings that have been published of the same species differ, especially drawings of the immature stages.

The lesions may also vary on different species of animals. In some cases that we have examined the lesions have been very severe and the acari scarce, and in others the reverse has been the case. In many cases no doubt the lesions are mainly produced by either bacteria or a fungus, the acari infection only being the primary cause. In Sinkobo, a common and severe skin disease of cattle in Central Africa, the lesions are caused by a fungus and possibly also bacteria, but either *Psoroptes* or *Demodex* are usually the primary cause.

Finally, the mites can usually be easily transmitted from one species of animal to another under suitable conditions, although it must be admitted in some cases they are difficult to transmit. This, however, is only to be expected, because it should be easier to transmit a strain of *Sarcoptes* that has constantly been transmitted from one species of animal to another than a strain that has lived on a single host species for a great number of generations.

A number of experiments have been undertaken at this laboratory from 1913 onwards to ascertain whether mange could be transmitted from one species of domestic animal to another. The results of these experiments, which were carried out by keeping animals in close contact with one another (unless otherwise stated) are recorded below, together with the results of other experiments and observations that have been undertaken and recorded in Europe.

Cameron (Parasit., XVII, iii, pp. 278-283, 1925) records infection experiments with *Sarcoptes* of cattle by keeping a horse and two sheep in close contact with infected bulls, and also by placing acari and their ova on the healthy animals. He also records placing acari on two white rabbits, two white rats, a cat, and on himself, but all these experiments gave negative results. One of the bulls used for these experiments became spontaneously cured, and this was attributed to the animal having been kept in a pen and exposed to sunlight (there being no overhead shelter), although the animals became cured during the winter in Canada.

Other authorities have also carried out similar experiments and failed to transmit the disease, the cause of their failures being no doubt due to the fact that the clean animals were well fed and in very healthy condition, and not to the fact that the parasites could not have been transmitted to the species of animals tested, or to the animals being kept in the sun. Recently I infected two horses with mange from an infected horse, and they were both turned out to graze on the veld. For two or three months their lesions spread rapidly, then they commenced to improve in condition owing to improvement of the veld, and the disease disappeared without treatment. These animals were kept under observation for a year after the lesions had disappeared and they remained healthy. I could also cite similar cases with other animals.

Mange is much more prevalent in South Africa during the winter months than during the summer, and this I attribute to the general improvement in the health of the animals during the summer. In the winter the rainfall is very low, and the vegation on the veld becomes very dry, with the result that the animals fall off in condition and become very liable to mange infection.

1. **Sarcoptes scabiei bubulus** (Oudemans) Figs. 1 and 2.

Sarcoptes scabiei var bovis Cameron, *Parasit.*, XVI, pp. 256-265, f. 1-6 (1924).

Acarus bubulus Oudemans, *Tijds. Ent.*, LXIX, p. 19 (1926).

Acarus bubulus Oudemans, *Archiv. Néerland. Sci. Exact. et Natur.*, pp. 232-259, f. 45-85 (1926).

Common and widely distributed on cattle in the Union. I have transmitted it to a horse, pig and goat, but failed to transmit it to one dog and six sheep. A number of cases of human beings becoming infected with this variety have been recorded in Europe.

2. **Sarcoptes scabiei caprae** Fürstenburg.

Sarcoptes caprae Fürstenburg, *Krätzm.*, p. 214, f. 7 (1861).

Common and widely distributed on both Angora and Boer goats in the Union. I have transmitted it to a horse, calf and sheep, but only a very small percentage of sheep appeared to be susceptible. Shilston (1916) also transmitted it to pigs, cattle and a sheep. It only occurs on the faces of Merino sheep where there is no wool. One of our natives became infected after handling a dead infected goat. It has also been transmitted to pigs and man in Europe.

3. **Sarcoptes scabiei equi** Raspail (1834).

Sarcoptes equi Gerlach, *Krätze*, p. 72, Pl. 2, f. 8-10 (1857).

Sarcoptes scabiei var. equi (Gerl.), Buxton, *Parasit.*, XIII, pp. 115-144, f. 1-22, Pl. 7 (1921).

Common and widely distributed on horses throughout the Union. I have transmitted it to two calves and a goat, but failed to transmit it to a pig, dog, rat, and three sheep. A number of cases of human beings becoming infected with this variety have been recorded in Europe.

4. **Sarcoptes scabiei megnini** *nom. nov.*

Sarcoptes scabiei var. ovis Mégnin, *Insect.*, *Arachn.*, *Crustac.*, p. 168 (1880), *nec* Hering, 1838.

Sarcoptes ovis (Mégn.), Can and Kram., *Demod und Sarc.*, p. 13 (1899).

This variety has been found on hairy sheep in South Africa, but it is by no means common. On these animals the infection occurs on the body and legs, as well as on the head and face. I have succeeded in transmitting it to Merino sheep, goats, and a calf. It appears to be easier to transmit this variety to Merino sheep than the variety *caprae*.

5. **Sarcoptes scabiei precox** Canestrini.

Sarcoptes scabiei var. cuniculi Neumann, *Revue vétérinaire, mars* (1892), *nec. S. cuniculi Gerlach*, 1857.

Sarcoptes precox Canestrini, *Prosp. Acarof.*, VI, p. 750 (1894).

This is a common parasite of domestic rabbits in South Africa. The infection commences either at the tip of the nose or on the legs, and then spreads to the face, ears, and sometimes on to the body. This variety has been transmitted to the guinea-pig in Europe, but Neumann failed to transmit it to cattle, horses, sheep, and dogs.

6. **Sarcoptes scabiei suis** Gerlach.

Sarcoptes suis Gerlach, *Krätze*, p. 137, Pl. 3, f. 15, 16 (1857).
Sarcoptes suis (Gerl.), Can. and Kram., *Demod. und Sarc.*, p. 14 (1899).

Occurs on pigs, but is not very common. I have transmitted it to a calf, which only remained infected about two months, also to a goat. It has been transmitted to man in Europe.

7. **Sarcoptes scabiei strepsiceros** Bedford.

We have received a portion of skin of a *Strepsiceros strepsiceros* (Cape Koodoo) from the Grahamstown District, Cape Province, grossly infected.

8. **Sarcoptes scabiei var.**

In August, 1916, I received a skin of a hartebeest from the Rustenburg District, Transvaal, badly infected with mange. On the 13th August a portion of the skin was tied onto the back of a goat. On the 18th the skin was removed, and the goat was showing signs of infection. During September the goat showed marked signs of infection on the back and acari were fairly numerous. In October the infection began to decrease. On the 9th November the goat was only very slightly infected, and by the 8th December it had entirely recovered. As the parasites lived on the goat for several generations the transmission must be regarded as positive.

9. **Sarcoptes scabiei var.**

A piece of skin of a *Gorgon taurinus* (blue wildebeest), was received from Mr. R. Daly in July, 1930, and found to be infected with *Sarcoptes*. The animal was shot at Maasstroom in the Northern Transvaal and was reported to be infected on the head and shoulders.

10. **Sarcoptes scabiei var.**

Pieces of skin of a *Raphiceros campestris* (steenbuck) were received from the Magistrate at Kuruman, Cape Province, on the 14th January, 1929, and were found to be infected with *Sarcoptes*. The animal was shot in the Kalahari, and it was reported that other game had been noticed which appeared infected.

11. Sarcoptes scabiei var.

A piece of skin of a silver jackal (*Vulpes chama*) heavily infected with parasites, was received from Mr. R. Paine, the Government Veterinary Officer at Grahamstown, Cape Province, in September, 1930.

In addition to the above, *Sarcoptes scabiei canis* Gerlach and *Sarcoptes scabiei leonis* Canestrini have been recorded from dogs and a lion in Europe. The latter was found on a lion in a menagerie in France.

Genus *Psoroptes* Gervais.

Psoroptes Gervais, *Ann. Sci. Nat.* (2). XV, p. 9 (1841).

Dermatodectes Gerlach, *Krätze*, p. 29 (1857).

Dermatocoptes Fürstenburg, *Krätzm.*, p. 220 (1861).

This genus contains several species which live either on the skin or in the ears of various animals, causing intense irritation and producing symptoms commonly known as " scab ".

Genotype: *Sarcoptes* equi Hering.

1. Psoroptes bovis (Gerlach).

Dermatodectes bovis Gerlach, *Krätze*, p. 114, Pl. 5 (1857).

Psoroptes communis var. bovis Railliet, Zool., ed. 2, p. 669 (1893).

Psoroptes bovis (Gerlach), Can. and Kram., *Demod. und Sarc.*, p. 16 (1899).

Scab in cattle usually commences at the base of the tail or, less frequently, on the neck or withers, and gradually extends, if not checked, to neighbouring parts of the body. It is widely distributed in the Union, but is nowhere common. Specimens have also been received from Angola and South West Africa.

2. Psoroptes caprae.

This variety occurs in the ears of goats; it is widely distributed throughout the Union.

3. Psoroptes cuniculi (Delafond).

Dermatodectes cuniculi Delafond, 1859 (*fide* Railliet, *Zool.*, ed. 2, p. 671, 1893).

Psoroptes communis var. cuniculi Railliet, *Zool.*, ed. 2, p. 671 (1893).

Psoroptes cuniculi (Delafond), Can. and Kram., *Demod. und Sarc.*, p. 17 (1899).

A common parasite in the ears of domestic rabbits in South Africa. In some cases crusts are formed, entirely filling up the ear cavities, and the mites may even spread to the face, neck, body, and limbs. They are also able to live on the bodies of sheep for periods up to seventeen days, but acari of the second generation die before reproducing.

4. **Psoroptes equi** (Hering).

Sarcoptes equi Hering, *N. Act. Ac. Leop.*, XVIII, ii, p. 585, Pl. 43, f. 1, 2 (1838).

Dermatocoptes communis Fürstenburg, *Krätze*, p. 220, Pl. 12-15 (1861).

Psoroptes equi (Hering), Can. and Kram., *Demod. und Sarc.*, p. 17 (1899).

According to Oudemans (Tijdschr. v. Ent., XL, p. 260, 1897) the name of this species should be *Psoroptes exulcerans* (Linné), *nec. P. equi* Hering.

Scrapings containing this variety have been received from Mr. G. McIntyre taken from a horse at George, Cape Province, on the 14th July, 1928; also specimens from the Government Veterinary Officer, Dundee, Natal, taken off a horse on the 5th September, 1929. It chiefly affects the neck, withers, rump, and base of the tail of its host.

5. **Psoroptes ovis** (Hering).

Sarcoptes ovis Hering, *N. Act. Ac. Leop.*, XVIII, ii, p. 594, Pl. 44, f. 3, 4 (1838).

Psoroptes communis var. ovis Railliet, *Zool.*, ed. 2, p. 670 (1893).

Psoroptes ovis (Hering), Can. and Kram., *Demod. und Sarc.*, p. 17 (1899).

Psoroptes communis var. ovis (Hering), Bedford, *Repts.*, Dir. Vet. Res., Un. S. Afr., III-IV, pp. 101-102, f. 1-5 (1915).

This is an extremely common parasite of sheep in South Africa. The acari live on the skin of their hosts, causing scabs and crusts to be formed and the wool to drop off. Infection usually commences on the body, and may gradually spread all over the woolly parts of the animals, and even in the ears and orbital fossae.

6. **Psoroptes natalensis** Hirst.

Psoroptes natalensis Hirst, *Ann. Mag. Nat. Hist.* (9), IV, p. 524 (1919).

This species was described from specimens taken off cattle at Richmond, Natal, and we have received specimens taken off the same hosts in various parts of the Union. Hirst (1922) states that Mégnin's specimens (from a buffalo from Cochin-China) determined by him as *P. longirostris* = *P. communis* are this species. The male differs from that of *P. communis* in having two of the setae on each of the abdominal lobes distinctly flattened and blade-like near their distal extremities. This species is found on the same parts of the body as *P. bovis*.

Genus Chorioptes Gervais.

Symbiotes Gerlach, *Krätze*, p. 30 (1857), *nec* Redtenbacher, 1849.

Chorioptes Gervais, *Zool. méd.*, I, p. 463 (1859).

Dermatophagus Fürstenburg, *Krätzm.*, p. 217 (1861).

The mites belonging to this genus produce symptoms known as Chorioptic or Symbiotic mange. Species are found on horses, cattle, sheep, and goats in Europe, but *caprae* is the only one that has so far been recorded from the Union. The mites live on the skins of their hosts, and infection is usually restricted either to the feet or base of the tail in cattle, but in some cases may spread to the neck, back, belly, etc.

1. **Chorioptes caprae** Gervais and Beneden.

Chorioptes caprae Gervais and Beneden, *Zool. Méd.*, I, p. 463 (1859).

Chorioptes caprae (Gerv. and Bened.), Can. and Kram., *Demod. und Sarc.*, p. 18 (1899).

Hutcheon (1895) recorded this variety as being common on Angora goats in this country, and stated that it was frequently transmitted to Boer goats. Scrapings from the legs of two Angora goats (received from Mr. A. Matthew, Government Veterinary Officer, Bedford, Cape Province), contained specimens of this species.

Genus Otodectes Canestrini.

Otodectes Canestrini, *Psorp. Acaeof.*, VI, p. 726 (1894).

This genus contains but a single species (*Otodectes cynotis* Hering), of which there are three varieties known to occur in the ears of dogs, cats, and ferrets in Europe. The species has not yet been recorded from the Union, but probably occurs here in the ears of dogs and cats.

Family CYTOLEICHIDAE.

This is a small family containing two genera. The species are minute and are found in various situations in their hosts, such as the subcutaneous tissues. The genus *Laminosioptes* contains a single species (*L. cysticola* Vizioli) which occurs in fowls in Europe, but has not yet been recorded from the Union. It can be distinguished by the elongate form of its body and the presence of a line between the cephalothorax and abdomen. Infected fowls have cysts of various sizes in the subcutaneous tissues. Only dead mites are found in the cysts, the living ones being found in the tissues.

Genus Cytoleichus Mégnin.

Cytoleichus Mégnin, *J. Anat. et Physiol.*, XV, p. 150 (1879).

Cytodites Railliet, *Zool.*, ed. 2, p. 678 (1893).

In this genus the body is oval and there is no demarcation between the cephalothorax and abdomen; the legs terminate in a small sucker whereas in *Laminosioptes* the two front pairs end in a claw and the two hind pairs in a claw and suckerless peduncle.

1. **Cytoleichus nudus** (Vizioli).

Sarcoptes nudus Vizioli, *Giorn. Anat. Fisiol.*, I, p. 257 (1870).

Cytoleichus sarcoptoides Mégnin, *J. Anat. et Physiol.*, XV, p. 150, Pl. 8 (1879).

Cytoleichus nudus (Viz.) Can. & Kram., Demod. und Sarc., p. 9 (1899).

Cytoleichus nudus (Viz.) Hirst, Mites Injur. to Dom. Anim., p. 59, f. 16 (1922).

This species is a common parasite of fowls in South Africa, and it has also been recorded from turkeys and pheasants in Europe. The mites live in the air-sacs and respiratory tract, and have also been found in the heart, liver and kidneys of fowls.

Family ANALGESIDAE.

Trouessart (1916) divided this family into four sections, the sections being regarded as subfamilies.

Key to the Subfamilies.

1. Integument strongly chitinized; body usually elongate. Species living on or in the feathers of birds 2

   Integument not strongly chitinized; body generally very short and circular. Species living on the skins of birds Epidermoptinae, p. 266.

2. Abdomen of ♀ bilobed posteriorly. Species mainly living on the wing feathers, also on the feathers of the back and flanks ... ... Proctophyllodinae, p. 262.

   Abdomen of ♀ not bilobed posteriorly 3

3. Males usually with either both pairs of forelegs enlarged, but rarely the third or fourth pair. Females with two or more dorsal plates. Species living on the wing feathers ... ... Pterolichinae, p. 240.

   Males may be much larger than the females and with the third or fourth pair of legs enormously developed. Tarsi of first two pairs of legs usually with a triangular tubercle on the ventro-external aspect. Females resembling the deuto-nymphs. Species living on the feathers other than the wing feathers Analgesinae, p. 259.

Subfamily PTEROLICHINAE.

This is a large subfamily comprising thirty-five genera.

Key to the South African Genera.

1. Epimera i united to sternum in both sexes 2

   Epimera i free in ♀, free or united in ♂ 13

2. Third and fourth pairs of legs submedial 3

   Third and fourth pairs of legs marginal 5

3. Body short, scarcely longer than broad ... *Freyana*, p. 242.

   Body more or less elongate 4

4. Abdomen with some lancet or leaf-like setae *Halleria*, p. 243.

Setae on abdomen normal; second and third joints of first two pairs of legs dilated ... ... *Microspalax*, p. 244.

5. Third pair of legs of ♂ enormously developed 6
Third pair of legs of ♂ not enormously developed 8

6. ♂: posterior margin of abdomen either rounded or with two short lobes ... ... *Pteronyssus*, p. 258.
♂: posterior margin of abdomen bilobed, deeply emarginated between the lobes 7

7. ♂: Lobes on posterior margin of abdomen connected by a hyaline membrane ... ... *Buchholzia*, p. 257.
♂: Lobes on posterior margin of abdomen not connected by a hyaline membrane ... ... *Giebelia*, p. 257.

8. ♀: abdomen with a conical prolongation posteriorly; ♂ with third pair of legs dilated ... *Columellaia*
♀: abdomen without a conical prolongation posteriorly; ♂ with third pair of legs normal or dilated 9

9. ♂ with third and fourth pairs of legs almost equal 10
♂ with fourth pair of legs longer and broaded than third pair ... ... *Syringobia*, p. 255.

10. All the legs slender 11
All the legs short, their joints as long as broad *Sammonica*, p. 252.

11. Abdomen of ♂ deeply incised posteriorly 12
Abdomen of ♂ almost rounded posteriorly *Plutarchia*, p. 256.

12. Thoracic groove well developed, with fold of integument of cephalothorax in that of abdomen ... *Thecarthra*, p. 251.
Fold of thoracic groove normal ... ... *Anoplonatus*, p. 252.

13. Epimera i free in ♀, with a sharp-pointed sternum between their proximal ends 14
Epimera i free in ♀, without a sharp-pointed sternum between their proximal ends; one pair of vertical setae on cephalothrax 16

14. Cephalothorax with one median vertical seta 15
Vertical seta on cephalothorax absent ... *Arenzoaria*, p. 248.

15. Epimera i of ♂ free, similar to ♀ ... ... *Chauliacia*, p. 251.
Epimera i of ♂ joined to sternum ... ... *Eustathia*, p. 251.

16. Epimera i of ♂ free, similar to ♀ 17
Epimera i of ♂ joined to sternum 23

17. Anterior dorsal plate only 18
Two dorsal plates 20

18. Body elongate 19
Body short and round ... ... *Sphaerogastra*, p. 255.

19. Anal suckers absent or very small ... *Dermoglyphus*, p. 254.
Anal suckers normal ... ... *Paralges*, p. 257.

20. All the legs equally developed 21
Fourth pair of legs of ♂ more developed than the third pair 22

21. Notogastric plate of ♀ forming a hollow filled with plaited tissues, reinforced on the abdominal margins *Gabucinia*, p. 250.
Notogastric plate of ♀ well developed, not forming a hollow ... ... *Pterolichus*, p. 244.

22. Fourth pair of legs of ♂ without an ambulacrum, but with a strong claw ... ... *Xoloptes*, p. 254.
Fourth pair of legs of ♂ with an ambulacrum *Pseudalloptes*, p. 253.

23. ♂: third pair of legs thick, fourth pair small; ♀: with horseshoe-shaped epigynium ... *Bdellorhynchus*, p. 253.
♂: third and fourth pairs of legs equally developed; ♀: without an epigynium ... ... *Falculifer*, p. 253.

Genus Freyana Haller.

Freyana Haller, *Zeit. f. wiss. Zool.*, XXX, p. 81 (1877).

Genotype: *Dermaleichus anatina* C. L. Koch.

Key to the South African Species.

1. Legs long and slender 2
Legs short, thick-set; abdomen of ♂ lobed ... *F. marginata.*

2. Scutum porose ... ... *F. pectinata.*
Scutum not porose 3

3. Apex of abdomen of ♂ bilobed, each lobe divided into three small lobes ... ... *F. oblonga.*
Apex of abdomen of ♂ not bilobed 4

4. Apex of abdomen entirely rounded ... ... *F. gracilipes.*
Apex of abdomen of ♀ only entirely rounded ... *F. pelargica.*

1. **Freyana gracilipes** Trouessart and Mégnin.

F. gracilipes Trt. & Mégn., *Naturaliste*, p. 395, f. 2 (1884).

F. (*Eufreyana*) *gracilipes* (T. & M.) Can. & Kram., *Demod. und Sarc.* p. 31 (1899).

Recorded taken off *Ephippiorhynchus senegalensis* (saddle-bill stork).

2. **Freyana marginata** Trouessart.

F. marginata Trt., *Bull. Soc. Étude. sci. Angers.*, XVI, p. 96 (1886).

F. (Eufreyana) marginata (Trt.) Can. & Kram., Demod. und Sarc., p. 33 (1899).

Described from specimens taken off *Rhynchops flavirostris* (African skimmer).

3. **Freyana oblonga** Trouessart and Neumann.

F. oblonga Trt. & Neu., *Bull. sci.*, France-Belgique, XIX, p. 334 (1888).

F. (Eufreyana) oblonga (Trt. & Neu.) Can. & Kram., Demod. und Sarc., p. 31 (1899).

Described from specimens taken off hadadah ibis, *Hagedashia hagedash* (= *Ibis hagedash*).

4. **Freyana pectinata** Trouessart.

F. (Eufreyana) pectinata Trouessart, *Bull. Soc. Étud. sci. Angers*, XVI, p. 95 (1886).

F. (Eufreyana) pectinata (Trt.) Can. & Kram., Demod. und Sarc., p. 31 (1899).

Described from specimens taken off *Scopus umbretta* Gm.

5. **Freyana pelargica** Trouessart and Neumann.

F. pelargica Trt. and Neu., *Naturaliste*, p. 396 (1884).

F. (Eufreyana) pelargica (Trt. & Neu.), Can. & Kram., Demod. und Sarc., p. 31 (1899).

Recorded taken from *Ciconia ciconia* (white stork) and black stork, *Melanopelargus niger* (= *C. nigra*).

Genus Halleria Trouessart and Mégnin.

Halleria Trt. & Mégnin, *Bull. Soc. Angers*, XIV, p. 40 (1885).

Genotype: *Halleria hirsutirostris* Trouessart and Mégnin.

Key to the Species.

1. Hind legs short, not reaching hind margin of body — *H. hirsutirostris.*

Hind legs long, reaching hind margin of body — *H. ceratorhina.*

1. **Halleria ceratorhina** Trouessart.

F. (Halleria) ceratorhina Trt., *Bull. Soc. Étud. sci. Angers*, XVI, p. 99 (1886).

F. (H.) ceratorhina (Trt.) Can. & Kram., Demod. und Sarc., p. 34 (1899).

Described from specimens taken off wood ibis, *Ibis ibis* (= *Tantalus ibis*).

2. **Halleria hirsutirostris** Trouessart and Mégnin.

F. (*Halleria*) *hirsutirostris* Trt. & Mégn., *Bull. Soc. Étud. sci. Angers*, XIV, p. 41, f. 6 (1885).

F. (H.) hirsutirostris (Trt. & Mégn.) Can. & Kram., Demod. und Sarc., p. 33 (1899).

Described from specimens taken off greater flamingo, *Phoenicopterus major* (=*P. antiquorum*).

Genus Microspalax Trouessart and Mégnin.

Microspalax Trt. & Mégnin, *Journ. Microgr.*, VIII, p. 152 (1884).

This genus includes a few species found on Hydrobatidae, Diomedeidae and domestic turkey.

Genotype: *Microspalax manicata* Trouessart and Mégnin.

1. **Microspalax chanayi** Trouessart.

Freyana (M.) chanayi Trt., *Journ. Microgr.*, IX, p. 114 (1885).

♂, ♀. *Freyana (M.) chanayi* (Trt.) Can. & Kram., Demod. und Sarc., p. 36 (1899).

Recorded taken off turkeys in Europe.

2. **Microspalax manicata major** Trouessart and Neumann.

F. (Microspalax) manicata major Trt. & Neu., *Bull. sci.*, France-Belgique, XIX, p. 336 (1886).

F. (M.) manicata major (T. & N.) Can. & Kram., Demod. und Sarc., p. 35 (1899).

Described from specimens taken off *Daption capensis* (Cape sea-pigeon).

Genus Pterolichus Robin.

Pterolichus Robin, *Comp. ren. heb. Séanc. Mém. Soc. Biol.*, LXVI, p. 786 (1868).

Genotype: *Pterolichus obtusus Robin.* Type host: *Perdix rubra.*

1. **Pterolichus bicaudatus** (Gervais).

Tyroglyphus bicaudatus Gervais, in Walkenaer, *Hist. nat. Ins.*, Apt., iii, p. 262 (1844).

P. (Eupterolichus) bicaudatus (Gerv.) Can. & Kram., Demod. und Sarc., p. 46 (1899).

This species is found on the South African ostrich. It has also been recorded from the American ostrich *(Rhea americana).*

2. **Pterolichus buchholzi** (Canestrini).

Dermaleichus buchholzi Can., *Att. Real. Ist. Veneto Sci., Lett. ed. Art.* (5), V, p. 64 (1878).

P. (Eupterolichus) buchholzi (Can.) Can. & Kram., Demod. und Sarc., p. 52 (1899).

Recorded taken off grey plover, *Squatarola squatarola* (=*Charadrius squatarola*) and *Limosa limosa* (black-tailed godwit).

2A. **Pterolichus buchholzi fascigera** Mégnin and Trouessart.

P. buchholzi fascigera Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 428 (1884).

P. (E.). buchholzi fascigera (Meg. & Trt.) Can. & Kram., Demod. und Sarc., p. 52 (1899).

Recorded taken off *Arenaria interpres* (turnstone), redshank, *Totanus totanus (= T. calidris)*, and knot, *Calidris canutus (=Tringa canutus)*.

2B. **Pterolichus buchholzi securicata** Mégnin and Trouessart.

P. buchholzi securicatus Mégn. & Trt., Jour. Microgr., Paris, VIII, p. 428 (1884).

P. (E.) buchholzi securicatus (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 53 (1899).

Described from specimens taken off curlew sandpiper, *Erolia testacea (=Tringa subarquata)*.

3. **Pterolichus charadrii** (Canestrini).

Dermalcichus charadrii, Can., *Att. Real. Ist. Ven. Sci., Lett. ed Art.* (5), V, p. 48 (1878)

P. (Eupterolichus) charadrii (Can.) Can. & Kram., Demod. und Sarc., p. 39 (1899).

Recorded from *Charadrius hiaticula* (ringed plover) and other Charadriiformes.

4. **Pterolichus ciconiae** Canestrini and Berlese.

Pterolichus ciconiae Can. & Berl., *Att. Soc. Veneto-Trent.*, Padova, VII, p. 145 (1880).

P. (Eupterolichus) ciconiae (Can. & Berl.) Can. & Kram., Demod. und Sarc., p. 47 (1899).

Described from specimens taken off white stork, *Ciconia ciconia (= C. alba)*.

5. **Pterolichus columbi major** Mégnin and Trouessart.

P. columbi major Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 429 (1884).

P. (Eupterolichus) columbi major (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 53 (1899).

Recorded taken off African crested grebe, *Podiceps infuscata (=P. cristata)*.

6. **Pterolichus cuculi** Mégnin and Trouessart.

P. cuculi Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 332 (1884).

P. (Eupterolichus) cuculi (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 47 (1899).

Described from specimens taken off European cuckoo (*Cuculus canorus*) and other birds. A slight variety has been found on the European bee-eater *(Merops apiaster)*.

7. **Pterolichus minor** Mégnin and Trouessart.

P. minor Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 216 (1884).

P. (Eupterolichus) minor (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 40 (1899).

Described from specimens taken off *Falco subbuteo* (hobby).

8. **Pterolichus marginatus** Trouessart.

P. marginatus Trt., *Bull. Soc. Etud. sci. Angers.*, XVI, p. 104 1886).

P. (Eupterolichus) marginatus (Trt.) Can. & Kram., Demod. und Sarc., p. 42 (1899).

Described from specimens taken off hadadah ibis, *Hagadashia hagedash (=Ibis hagedash).*

9. **Pterolichus martini** Trouessart.

P. martini Trt., *Jour. Microgr.*, Paris, IX, p. 116 (1885).

P. (Eupterolichus) martini (Trt.) Can. & Kram., Demod. und Sarc., p. 39 (1899).

Described from specimens taken off *Sterna hirundo* (common tern).

10. **Pterolichus ninnii** (Canestrini).

Dermaleichus ninnii Can., *Atti. Real. Ist. Ven. Sci., Lett. ed. Art.* (5) V, p. 56 (1878).

P. (Eupterolichus) ninnii (Can.) Can. & Kram., Demod. und Sarc., p. 49 (1899).

Described from specimens taken off *Numenius arquatus* (curlew).

11. **Pterolichus nisi** (Canestrini).

Dermaleichus nisi Can., *Atti. Real. Ist. Ven. Sci., Lett. ed. Art.* (5) V, p. 54 (1878).

P. (Eupterolichus) nisi (Can.) Can. & Kram., Demod. und Sarc., p. 46 (1899).

Recorded taken off Montagu's harrier, *Pygargus pygargus (=Circus pygargus)* and *Pernis apivorus* (honey buzzard).

12. **Pterolichus numenii** (Canestrini).

Dermaleichus numenii Can., *Atti. Real. Ist. Ven. Sci., Lett. ed. Art.* (5), V, p. 61 (1878).

P. (Eupterolichus) numenii (Can.) Can. & Kram., Demod. und Sarc., p. 50 (1899).

Described from specimens taken off wimbrel, *Phaeopus phaeopus (=Numenius phaeopus).*

13. **Pterolichus pavonis** Oudemans.

Pterolichus pavonis Oudms., *Ent. Bericht.*, No. 21, p. 210 (1905).

Described from specimens taken off *Pavo cristatus* (peacock). The female differs from that of *P. obtusus* Rob. in having a much broader posterior plate on the dorsum.

14. **Pterolichus phoenicopteri** Mégnin and Trouessart.

P. phoenicopteri Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 384 (1884).

P. (Eupterolichus) phoenicopteri (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 52 (1899).

Described from specimens taken off greater flamingo, *Phoenicopterus major (=P. antiquorum).*

15. **Pterolichus porzanae** (Canestrini).

Dermaleichus porzanae Can., *Atti. Real. Ist. Ven. Sci., Lett. ed. Art.* (5) V, p. 49 (1878).

P. (Eupterolichus) porzanae (Can.) Can. & Kram., Demod. und Sarc., p. 51 (1899).

Described from specimens taken off *Ortygometra porzana* (spotted crake).

16. **Pterolichus rallorum** Robin.

P. rallorum Robin. *Jour. Anat. et Physiol.*, XIII, p. 414 (1877).

P. (Eupterolichus) rallorum (Rob.) Can. & Kram., Demod. und Sarc., p. 50 (1899).

Described from specimens taken off corn-crake, *Crex crex (=Rallus crex).*

17. **Pterolichus rebergi gracilis** Mégnin and Trouessart.

P. rebergi gracilis Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 383, f. 49 (1884).

P. (Eupterolichus) rebergi gracilis (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 51 (1899).

Described from specimens taken off *Himantopus himantopus* (black-winged stilt).

18. **Pterolichus rubidus** (Trouessart).

P. rubidus, Trt., *Bull. Soc. Étud. sci. Angers*, XVI, p. 110 (1886).

P. (Eupterolichus) rubidus (Trt.) Can. & Kram., Demod und Sarc., p. 52 (1899).

Described from specimens taken off yellow-billed mollymawk, *Nealbatrus chlororhynchus (=Diomedea chlororhyncha).*

18A. **Pterolichus rubidus petalifera** Trouessart.

P. rubidus petalifera Trt., *Bull. Soc. ent. France*, p. 291 (1898).

P. (E.) rubidus petalifera (Trt.) Can. & Kram., Demod und Sarc., p. 52 (1899).

Described from specimens taken off the same host as the type.

19. **Pterolichus sculpturatus** Hirst.

P. sculpturatus Hirst., *Ann. Mag. Nat. Hist.* (9), V, No. 31, p. 121 (1920).

Described from specimens taken off ostriches at Onderstepoort, Transvaal. This species lives both on and inside the quills.

20. **Pterolichus serrativentris** Trouessart.

P. serrativentris, Trt., *Bull. Soc. Étud. sci. Angers*, XVI, p. 108 (1886).

P. (Eupterolichus) serrativentris (Trt.) Can. & Kram., Demod. und Sarc., p. 44 (1899).

Described from specimens taken off *Leptoptilus crumeniferus* (marabou stork).

21. **Pterolichus squatarolae** (Canestrini).

Dermalcichus squatarolae Can., *Atti. Real. Ist. Ven. Sci., Lett. ed Art.* (5), V, 9, 47 (1878).

P. (Eupterolichus) squatarolae (Can.) Can. & Kram., Demod. und Sarc., p. 39 (1899).

Described from specimens taken off *Squatarola squatarola* (grey plover).

22. **Pterolichus vexillarius minuta** Mégnin and Trouessart.

P. vexillarius minuta Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 431, f. 52 (1884).

P. (Eupterolichus) vexillarius minuta (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 54 (1899).

Described from specimens taken off crowned hornbill, *Rhynchaceros melanoleucus (= Tockus melanoleucus)*, and *T. erythrorhynchus* (red-billed hornbill).

Genus Avenzoaria Oudemans.

Avenzoaria Oudemans, *Ent. Berichten*, No. 21, p. 209 (1905).

This genus comprises twelve species found on Scolopacidae.

Genotype: *Dermaleichus totani* Canestrini.

1. **Avenzoaria asiatica** (Oudemans).

♂, ♀, ○. *Pterolichus asiaticus* Oudms., *Ent. Bericht.*, No. 20, p. 194 (1904).

♂, ♀, ○. *Avenzoaria asiatica* Oudms., *Tijd. v. Ent.*, LIII, p. 226, Pl. 12, f. 39-51 (1910).

Described from specimens taken off dusky sandpiper, *Erythroscelis fuscus (= Totanus fuscus)*, India.

2. **Avenzoaria australis** (Oudemans).

♂. *Pterolichus australis* Oudms., *Ent. Bericht.*, No. 20, p. 194 (1904).

♂. *Avenzoaria australis* Oudms., *Tijd. v. Ent.*, LIII, p. 214, Pl. 11, f. 30-32 (1910).

Described from specimens taken off dusky sandpiper, *Erythroscelis fuscus (= Totanus fuscus)*, India.

3. **Avenzoaria bengalensis** (Oudemans).

♂, ♀, o. *Pterolichus bengalensis* Oudms., *Ent. Bericht.*, No. 20, p. 193 (1904).

♂, ♀, o. *Avenzoaria bengalensis* Oudms., *Tijd. v. Ent.*, LIII, p. 206, Pl. 9, f. 8, 9; Pl. 10, f. 10-14 (1910).

Described from specimens taken off *Totanus totanus* (redshank), Bengal, India.

4. **Avenzoaria calidridis** (Oudemans).

♂, o. *Pterolichus calidridis* Oudms., *Ent. Bericht.*, No. 19, p. 172 (1904).

♂, o. *Avenzoaria calidridis* Oudms., *Tijd. v. Ent.*, LIII, p. 210, Pl. 10, f. 15-19 (1910).

Described from specimens taken off *Totanus totanus* (redshank), France.

5. **Avenzoaria grallatoris** (Oudemans).

o, L. *Pterolichus grallatoris* Oudms., *Ent. Bericht.*, No. 19, p. 172 (1904).

o, L. *Avenzoaria grallatoris* Oudms., *Tijd. v. Ent.*, LIII, p. 217, Pl. 11, f. 20-26 (1910).

Described from specimens found in the spools of the large quills of *Totanus totanus* (redshank), France.

6. **Avenzoaria indica** (Oudemans).

♂. *Pterolichus indicus* Oudms., *Ent. Bericht.*, No. 20, p. 193 (1904).

♂. *Avenzoaria indica* Oudms., *Tijd. v. Ent.*, LIII, p. 222, Pl. 11, f. 33-36 (1910).

Described from specimens taken off *Totanus totanus* (redshank), Bengal, India.

7. **Avenzoaria limicolae** (Oudemans).

o. *Pterolichus limicolae* Oudms., *Ent. Bericht.*, No. 19, p. 172 (1904).

o. *Avenzoaria limicolae* Oudms., *Tijd. v. Ent.*, LIII, p. 220, Pl. 11, f. 27-29 (1910).

Described from specimens found in the spools of the large quills of *Totanus totanus* (redshank), France.

8. **Avenzoaria limosae** (Buchholz).

Dermalcichus limosae Buchh., *Bemerk.*, p. 26, Pl. 2, f. 12, 13 (1869).

P. (Euptcrolichus) limosae (Buchh.) Can. & Kram., Demod. und Sarc., p. 49 (1899).

Recorded taken off *Erythroscelis fuscus* (dusky sandpiper) and other species of Scolopacidae.

8A. **Avenzoaria limosae selanura** (Mégnin and Trouessart).

Pterolichus limosae selanurus Mégn. & Trt., *Journ. Microgr.* Paris, VIII, p. 337 (1884).

P. (Euptcrolichus) limosac selenura (M. & T.) Can. & Kram., Demod. und Sarc., p. 49 (1899).

Described from specimens taken off bar-tailed godwit, *Vetola lapponica (= Limosa lapponica).*

9. **Avenzoaria totani** (Canestrini).

Dermaleichus totani Can., *Atti. Real. Ist. Ven. Sci., Lett. ed. Art.* (5), V, p. 60 (1878).

P. (Euptcrolichus) totani (Can.) Can. & Kram., Demod. und Sarc., p. 49 (1899).

Avenzoaria totani (Can.) Oudms., *Tijd. v. Ent.*, LIII, p. 197 (1910).

Described from specimens taken off redshank, *Totanus totanus (=T. calidris)*; ruff, *Philomachus pugnax (=T. pugnax)* and little stint, *Pisobia minuta (= Tringa minuta).*

10. **Avenzoaria tringae** (Oudemans).

♂, ♀. *Pterolichus totani* Berlese, Acari, Myrio. et Scorp. in Italia, Padova, fasc. 38, No. 2 (1887), *nec* Canestrini, 1878.

Pterolichus tringae Oudms., *Ent. Bericht.*, No. 19, p. 171 (1904).

♂, ♀. *Avenzoaria tringae* Oudms., *Tijd. v. Ent.*, LIII, p. 199 (1910).

Recorded by Berlese from redshank, *Totanus totanus (=T. calidris)*; ruff, *Philomachus pugnax (= T. pugnax)* and little stint, *Pisobia minuta (= Tringa minuta).*

Genus Gabucinia Oudemans.

Gabucinia Oudemans, *Ent. Bericht.*, p. 224 (1905).

Genotype: *Pterolichus delibatus* Robin.

1. **Gabucinia delibata** (Robin).

P. delibatus Robin, *Jour. Anat. et Physiol.*, XIII, p. 416 (1877).

P. (Eupterolichus) delibatus (Rob.) Can. & Kram., Demod. und Sarc., p. 43 (1899).

This species has been recorded taken off *Corvultur albicollis* (white-necked raven); pied crow, *Corvus albus (= C. scapulatus)*, and other species of Corvidae, also from Vulturidae.

Genus EUSTATHIA Oudemans.

Eustathia Oudemans, *Ent. Bericht.*, p. 218 (1905).
Genotype: *Pterolichus cultrifer* Robin.

1. **Eustathia cultrifer** (Robin).
   P. cultrifer Robin, *Jour. Anat. et Physiol.*, XIII, p. 408, Pl. 22, f. 8 (1877).
   P. (Eupterolichus) cultrifer (Rob.) Can. & Kram., Demod. und Sarc., p. 54 (1899).
   Described from specimens taken off European swift, *Micropus apus (= Cypselus apus).*

Genus CHAULIACIA Oudemans.

Chauliacia Oudemans, *Ent. Bericht.*, p. 218 (1905).
Genotype: *Pterolichus securiger* Robin.

Chauliacia securiger (Robin).
P. securiger Robin, *Jour. Anat. et Physiol.*, XIII, p. 406, Pl. 22, f. 9 (1877).
P. (Eupterolichus) securiger (Rob.) Can. & Kram., Demod. und Sarc., p. 55 (1899).
Described from specimens taken off European swift, *Micropus apus (= Cypselus apus).*

Genus THECARTHRA Trouessart.

Thecarthra Trouessart, *Bull. Soc. ent.*, France, p. 420 (1896).
Genotype: *Pterolichus theca* Mégnin and Trouessart.

1. **Thecarthra bouveti** (Mégnin and Trouessart).
   Pterolichus bouveti Mégn. & Trt., *Jour. MicrPogr.*, Paris, VIII, p. 435 (1884).
   Thecarthra bouveti (M. & T.) Can. & Kram., Demod. und Sarc., p. 72 (1899).
   Described from specimens taken of *Charadrius hiaticula* (ringed plover). Recorded by Oudemans (1906) from quills of *Totanus totanus* (redshank).

2. **Thecarthra longitarsa** (Mégnin and Trouessart).
   Pterolichus longitarsus Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 436 (1884).
   Thecarthra longitarsa (M. & T.) Can. & Kram., Demod. und Sarc., p. 71 (1899).
   This species has been recorded from grey plover, *Squatarola squatarola (= S. helvetica).*

3. **Thecarthra setigera** (Mégnin and Trouessart).
   Pterolichus setiger Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 435 (1884).

Thecarthra setigera (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 73 (1899).

Described from specimens taken off bar-tailed godwit, *Vetola lapponica (= Limosa rufa).*

4. **Thecarthra simplex tyroglyphina** (Trouessart and Neumann).

Pterolichus simplex tyroglyphinus Trt. & Neu., *Bull. sci., France Belgique*, XVI, p. 337 (1888).

Thecarthra simplex tyroglyphina (Trt. & Neu.) Can. & Kram., Demod. und Sarc., p. 72 (1899).

Described from specimens taken off white-winged tern, *Chlidonias leucoptera (= Hydrochelidon leucoptera).*

5. **Thecarthra theca** (Mégnin and Trouessart).

Pterolichus theca Mégn. & Trt., *Jour. Microgr.*, Paris, VIII, p. 434 (1884).

Thecarthra theca (Mégn. & Trt.) Can. & Kram., Demod. und Sarc., p. 73 (1884).

Recorded taken off Caspian tern, *Hydroprogne tschegrava (= Sterna caspia)*, and *Stercorarius parasiticus* (white-necked skua).

6. **Thecarthra trouessarti** Berlese.

T. trouessarti Berl., Acari, Myrio. et Scorp. in Italia, Padova, fasc. 83, No. 2 (1897).

T. trouessarti (Berl.) Can. & Kram., Demod. und Sarc., p. 72 (1899).

Described from specimens taken off turnstone, *Arenaria interpres (= Strepsilas interpres).*

Genus Anoplonotus Trouessart.

Anoplonotus Trouessart, *Bull. Soc. Zool. de France*, XL, viii-x, p. 214 (1916).

Genotype: *Pterolichus semaphora* Trouessart.

1. **Anoplonotus semaphorus** (Trouessart).

Pterolichus semaphora Trt., *Bull. Soc. Étud. sci., Angers*, XVI, p. 111 (1886).

Thecarthra semaphora (Trt.) Can. & Kram., Demod. und Sarc., p. 71 (1899).

Described from specimens taken off *Sterna hirundo* (common tern).

Genus Sammonica Oudemans.

Sammonica Oudemans, *Ent. Bericht.*, p. 192 (1904).

Genotype: *Syringobia ovalis* Trouessart. Type host: *Totanus flavipes* (Gm.).

1. **Sammonia interfolia** (Mégnin and Trouessart).

Pterolichus interfolia Mégn. & Trt., *Journ. Microgr.*, VIII, p. 433, f. 53b, c (1884).

♂, ♀. *Thecarthra interfolia* (M. & T.) Can. & Kram., Demod. und Sarc., p. 72 (1899).

Recorded by Oudemans (*Tijd. v. Ent.*, XLIX, p. 261, 1906) taken off *Totanus totanus* (redshank). The type host is *Totanus hypoleucus*.

Genus PSEUDALLOPTES Trouessart and Mégnin.

Pseudalloptes Trt. & Mégn., *Journ. Microgr.*, VIII, p. 531 (1884).

Genotype: *Pseudalloptes bisubulatus* Robin.

1. **Pseudalloptes pyriventris** Trouessart.

P. (Pseudalloptes) pyriventris Trouessart, *Bull. Soc. Angers*, XVI, p. 113 (1886).

P. (Pseudalloptes) pyriventris (Trt.) Can. & Kram., Demod. und Sarc., p. 60 (1899).

Described from specimens taken off *Scopus umbretta* (hammerhead).

1A. **Pseudalloptes pyriventris vegetans** Trouessart.

P. (Pseudalloptes) pyriventris var. vegetans Trouessart, *Bull. Soc. Étud. sci., Angers*, XXVIII (1899).

P. (Pseudalloptes) pyriventris var. vegetans (Trt.) Can. & Kram., Demod. und Sarc., p. 61 (1899).

Described from specimens taken off *Scopus umbretta* (hammerhead).

Genus FALCULIFER Railliet.

Falcifer Trouessart, *Journ. Microgr.*, IX, p. 69 (1885), *nec.* Meg. v, Mühlf. 1821 (Coleopt.).

Falculifer Railliet, *Rec. de Médec. vétér.* p. 6 (1896).

Genotype: *Dermaleichus rostratus* Buchholz.

1. **Falculifer rostratus** (Buchholz).

Dermaleichus rostratus Buchh., *Bemerk.*, p. 14, f. 1 (1869).

♂. ♀. *F. rostratus* (Buchh.) Can. & Kram., Demod. und Sarc., p. 68 (1899).

Recorded taken off domestic pigeons and other pigeons in Europe.

Genus BDELLORHYNCHUS Trouessart.

Bdellorhynchus Trouessart, *Jour. Microgr.*, Paris, IX, p. 109 (1885).

This genus includes two species.

Genotype: *Bdellorhynchus polymorphus* Trouessart.

Key to the Species.

1. First pair of legs with very long antenna-like setae *B. polymorphus.*
   First pair of legs without such setae ... ... *B. psalidurus.*

1. **Bdellorhynchus polymorphus** Trouessart.

B. polymorphus Trouessart, *Jour. Microgr.*, Paris, IX, p. 110, f. 7 (1885).

B. polymorphus (Trt.) Can. & Kram., Demod. und Sarc., p. 70 (1899).

Described from specimens taken off *Spatula clypeata* (European shoveller) and other species of Anatidae.

2. **Bdellorhynchus psalidurus** Trouessart.

B. psalidurus Trt., *Bull. Soc. Étud. sci. Angers*, XVI, p. 118 (1886).

B. psalidurus (Trt.) Can. & Kram., Demod. und Sarc., p. 70 (1899).

Described from specimens taken off Egyptian goose, *Alopochen aegyptiacus (= Chenalopex aegyptiacus).*

Genus Xoloptes Canestrini.

Xoloptes Canestrini, *Atti. Soc. Veneto. Trent.*, Padova, VI, p. 7 (1879).

This is a small genus comprising four species.

Genotype: *Pterolichus claudicans* Robin. Type host: *Coturnix.*

1. **Xoloptes didactylus** Trouessart.

X. didactylus Trouessart, *Jour. Microgr.*, Paris, IX, p. 113 (1885).

X. didactylus (Trt.) Can. & Kram., Demod. under Sarc., p. 67 (1899).

Described from specimens taken off white stork, *Ciconia ciconia (=C. alba).*

Genus Dermoglyphus Mégnin.

Dermoglyphus Mégnin. *Journ. Anat. et Physiol.*, XIII, p. 654 (1877)
Genotype: *Dermalichus elongatus* Mégnin.

Key to the Species.

1. ♂: posterior margin of body with one long seta on each side ... ... *D. minor.*
   ♂: posterior margin of body with three long setae on each side 2
2. Abdomen of ♂ rounded behind ... ... *D. elongatus.*
   Abdomen of ♂ slightly emarginated behind ... *D. diplectrum.*

1. **Dermoglyphus diplectrum** Trouessart.

D. diplectron Trouessart in Berlese, Acari, *Myr. et Scorp. in Ital.* facs. 80, No. 7 (1896).

♂. ♀. *D. diplectrum* (Trt.) Can. & Kram., Demod. und Sarc., p. 76 (1899).

Described from specimens taken off curlew sandpiper, *Erolia testacea (= Tringa subarquata).*

2. **Dermoglyphus elongatus** Mégnin.

Dermalichus elongatus Mégn., *Journ. Anat. et Physiol.*, XIII, p. 392 (1877).

♂, ♀. *Dermoglyphus elongatus* (Mégn.) Can. & Kram., Demod. und Sarc., p. 75 (1899).

This species has been recorded taken off domestic fowls in Europe. It lives inside the quills of the feathers.

3. **Dermoglyphus minor** (Nörner).

Analges minor Nörn., *Verh. Ges. Wien*, XXXII, p. 387, Pl. 19, f. 1-10 (1882).

♂, ♀. *Dermoglyphus minor* (Nörn.) Can. & Kram., Demod. und Sarc., p. 75 (1899).

Recorded taken off domestic fowls, guinea-fowl and turkeys in Europe. It lives inside the quills of the feathers.

Genus Sphaerogastra Trouessart.

Sphaerogastra Trouessart in Berlese, *Acari, Myr. et Scorp., in Ital.* Crypt. I, p. 41 (1897).

Genotype: *Sphaerogastra thylacodes* Trouessart.

1. **Sphaerogastra thylacodes** Trouessart.

S. thylacodes Trouessart in Berlese, *Acari, Myr. et Scorp. in Ital.* fasc. 88, No. 4, p. 41 (1897).

S. thylacodes (Trt.) Can. & Kram., Demod. und Sarc., p. 77 (1899).

Described from specimens taken off greenshank, *Glottis nebularius (= Totanus glottis)* and curlew sandpiper, *Erolia testacea.*

Genus Syringobia Trouessart and Neumann.

Syringobia Trt. & Neu., *Bull. sci. France Belgique*, XIX, p. 344 (1888).

Genotype: *Syringobia chelopus* Trouessart and Neumann.

Key to the South African Species.

1. Second joint of fourth pair of legs without spurs ..... *S. calceata.*
   Second joint of fourth pair of legs with spurs ..... *S. chelopus.*

1. **Syringobia calcarata** Oudemans.
   S. calcarata Oudms., *Ent. Bericht.*, I, No. 20, p. 193 (1904).
   ♂. *S. calcarata* Oudms., *Zool. Jahrbüch.*, XXVI, p. 584, Pl. 33, f. 41-43 (1908).

   Described from specimens taken off dusky sandpiper, *Erythroscelis fuscus (=Totanus fuscus).*

2. **Syringobia calceata** Trouessart
   S. calceata Trt., *Bull. Soc. ent. France*, p. 320 (1898).
   S. calceata (Trt.) Can. & Kram., Demod. und Sarc., p. 74 (1899).
   ♂, ♀, ○, L. *S. calceata* (Trt.) Oudemans, *Zool. Jahrbüch.*, XXVI, v, p. 574, Pl. 33, f. 20-40 (1908).

   Described from specimens taken off green sandpiper, *Tringa erythropus (= Totanus ochropus).*

3. **Syringobia calidridis** Oudemans.
   ○. *S. calidridis* Oudms., *Ent. Bericht.*, I, No. 19, p. 173 (1904).
   ○. *S. calidridis* Oudms., *Zool. Jahrbüch.*, XXVI, v, p. 587, Pl. 33, f. 48-50 (1908).

   Described from specimens taken off *Totanus totanus* (redshank).

4. **Syringobia chelopus** Trouessart and Neumann.
   S. chelopus Trt. & Neu., *Bull. sci. France-Belgique*, XIX, p. 344, Pl. 23, f. 1, 2 (1888).
   S. chelopus (Trt. & Neu.) Can. & Kram., Demod. und Sarc., p. 74 (1899).
   ♂, ♀, ○, L. *S. chelopus* (Trt. & Neu.) Oudemans, *Zool. Jahrbüch.*, XXVI, v, p. 566, Pl. 33, f. 1-19 (1908).

   Described from specimens found in the feathers of redshank, *Totanus totanus (= T. calidris).*

5. **Syringobia totani** Oudemans.
   ○. *S. totani* Oudms., *Ent. Bericht.*, I, No. 19, p. 173 (1904).
   ○. *S. totani* Oudms., *Zool. Jahrbüch.*, XXVI, v, p. 586, Pl. 33, f. 44-47 (1908).

   Described from specimens taken off *Totanus totanus* (redshank).

Genus Plutarchia Oudemans.

Plutarchusia Oudemans, *Ent. Bericht*, I, No. 19, p. 173 (1904).
Plutarchia Oudemans.

1. **Plutarchia chelopus** (Trouessart).
   Syringobia chelopus série anormale Trouessart, *Ann. Soc. Ent. France; Bull. Ent.* (9 & 23 May, 1894).

Plutarchusia chelopus Oudms., *Ent. Bericht.*, I, No. 19, p. 173 (1904).

♂, ♀, ○, L. *Plutarchia chelopus* Oudms., *Tijd. v. Ent.*, XLIX, p. 250, Pl. 10, f. 30-35; Pl. 11, f. 36-39 (1906).

Described from specimens taken off *Totanus totanus* (redshank).

Genus Paralges Trouessart.

Paralges Trouessart, *Journ. Microgr.*, IX, p. 112 (1885).

Genotype: *Paralges pachycnemis* Trouessart.

1. **Paralges deformis** (Trouessart and Neumann).

Paralges deformis Trt. and Neu., *Bull. Sci. France-Belgique*, XIX, p. 346 (1888).

Dermoglyphus deformis Can. & Kram., Demod. und Sarc., p. 76 (1899).

Described from specimens taken off grey lourie, *Crinifer concolor* (= *Schizorhis concolor*).

Genus Buchholzia Trouessart.

Buchholzia Trouessart, *Bull. Soc. Zool. de France*, XL, viii-x, p. 217 (1916).

Genotype: *Analges fuscus* Nitzsch.

1. **Buchholzia fuscus** (Nitzsch).

Analges fuscus Nitz. in Ersch and Grub., *Allg. Enc. Wissensch. u. Kün.* I, p. 252 (1818).

Pteronyssus fuscus (Nitz.) Can. & Kram., Demod. und Sarc., p. 84 (1899).

Described from specimens taken off osprey, *Pandion haliaetus* (= *Aquila haliaetus*).

Genus Giebelia Trouessart.*

Giebelia Trouessart, *Bull. Soc. Zool. de France*, XL, viii-x, p. 217 (1916).

Genotype: *Dermaleichus puffini* Buchholz.

1. **Giebelia puffini** (Buchholz).

Dermaleichus puffini Buchh., Bemerk. über die Art. der Gatt., Dermaleichus, p. 37 (1869).

Pteronyssus puffini (Buchh.) Can. & Kram., Demod. und Sarc., p. 84 (1899).

Recorded taken off *Dromas ardeola* (crab plover) and other birds.

* *Nec Giebelia* Kellogg, 1896 (Mallophaga).

Genus Pteronyssus Robin.

Pteronyssus Robin, *Comp. Séan. Acad. Sci.*, Paris, LXVI, p. 786 (1868).

Genotype: *Pteronyssus striatus* Robin. Type host: *Fringilla caelebs.*

1. **Pteronyssus gracilipes** Trouessart and Neumann.

P. gracilipes Trt. & Neu., *Bull. Sci., France-Belgique*, XIX, p. 353 (1888).

P. gracilipes Can. & Kram., Demod. und Sarc., p. 82 (1899).

Described from specimens taken off redshank, *Totanus totanus (=T. calidris).*

2. **Pteronyssus integer** Trouessart and Neumann.

P. integer Trt. & Neu., *Bull. Sci. France-Belgique*, XIX, p. 352, Pl. 24, f. 5 (1888).

P. integer (Trt. & Neu.) Can. & Kram., Demod. und Sarc., p. 82 (1899).

Described from specimens taken off spotted flycatcher, *Muscicapa striata (= M. grisola)*, a migrant to South Africa.

3. **Pteronyssus nuntiaeveris** Berlese.

P. nuntiaeveris Berl., Acari, Myr. et Scorp., Ital., fasc. 26, No. 5 (1884).

P. nuntiaeveris (Berl.) Can. & Kram., Demod. und Sarc., p. 82 (1899).

Described from specimens taken off European sandmartin, *Riparia riparia (= Cotyle riparia).*

4. **Pteronyssus obscurus** Berlese.

P. obscurus Berlese, Acari, Myr. et Scorp., Ital., repert and fasc. 18, No. 3 (1884).

P. obscurus (Berl.) Can. & Kram., Demod. und Sarc., p. 80 (1899).

Recorded taken off *Chelidonaria urbica* (house martin) and European sandmartin, *Riparia riparia (= Cotyle riparia).*

5. **Pteronyssus pallens** Berlese.

P. pallens Berlese, Acari, Myr. et Scorp. Ital. fasc. 24, No. 8 (1884).

P. pallens (Berl.) Can. & Kram., Demod. und Sarc., p. 81 (1899).

Described from specimens taken off *Acrocephalus arundinaceus* (great reed warbler), a migrant to South Africa.

6. **Pteronyssus truncatus** Trouessart.

P. truncatus Trt., *Bull. Soc. Étud. sci. Angers*, XIV, p. 49 (1885).

P. truncatus (Trt.) Can. & Kram., Demod. und Sarc., p. 81 (1899).

This species has been recorded taken off *Sternus vulgaris* in Europe and off *Lamprotornis sp.* in Senegal. It probably occurs on the European starling at Capetown, and may also occur on the South African species of *Lamprotornis*, of which there are two, and possibly other starlings as well.

Subfamily ANALGESINAE.

This subfamily comprises twelve genera.

Key to the South African Genera.

1. ♂: Third pair of legs broader than fourth pair 2
   ♂: Third pair of legs narrower than fourth pair; the first and second pairs normal, the latter without falciform tarsus 3
2. ♂: Third pair of legs with a caruncle; anal sucker well developed ... ... MÉGNINIA, p. 259.
   ♂: Third pair of legs without a caruncle ... ANALGES, p. 260.
3. ♂: Fourth pair of legs with an ambulacral caruncle PTERALLOPTES, p. 261.
   ♂: Fourth pair of legs without a caruncle XOLALGES, p. 261.

Genus MÉGNINIA Berlese.

Mégninia Berlese, Acari, Myr. et Scorp., Ital., fasc. 4, No. 5 (1881).
Genotype: *Dermalichus cubitalis* Mégnin.

1. **Mégninia aestivalis** Berlese.

M. aestivalis Berlese, Acari, Myr. et Scorp., Ital., fasc. 25, No. 10 (1883).

M. aestivalis (Berl.) Can. & Kram., Demod. und Sarc., p. 98 (1899).

Described from specimens taken off European swift, *Micropus apus (= Cypselus apus).*

1A. **Mégninia aestivalis subintegra** Berlese.

M. aestivalis var. subintegra Berl., Acari, Myr. et Scorp., Ital. fasc. 26, No. 1 (1883).

M. aestivalis var. subintegra (Berl.), Can. & Kram., Demod. und Sarc., p. 99 (1899).

Recorded taken off *Chelidonaria urbica* (house martin) and European sandmartin, *Riparia riparia (= Cotyle riparia)* in *Italy.*

2. **Mégninia columbae** (Buchholz).

Dermaleichus columbae Buchh., *Bemerk.*, p. 36, Pl. 3, f. 22 (1869).

♂, ♀. *Mégninia columbae* (Buchh.) Can. & Kram., Demod. und Sarc., p. 95 (1899).

Recorded taken off domestic pigeons and other pigeons in Europe.

3. **Mégninia cubitalis** (Mégnin).

Dermaleichus cubitalis Mégn., *Journ. Anat. et Physiol.*, XIII, p. 504, Pl. 27 (1877).

Mégninia cubitalis (Mégn.) Can. & Kram., Demod. und Sarc., p. 94 (1899).

Recorded taken off turkeys in Europe.

4. **Mégninia gallinulae** (Buchholz).

Dermaleichus gallinulae Buchh., Bemerk. über Art. der Gat. Derma., p. 28 (1869).

Mégninia gallinulae (Buch.) Can. & Kram., Demod. und Sarc., p. 98 (1899).

Recorded taken off *Ortygometra porzana* (spotted crake) in Europe.

4A. **Mégninia gallinulae major** Berlese.

M. gallinulae var. major Berl., Acari, Myr. et Scorp., Ital., fasc. 26, No. 8 (1883).

M. gallinulae var. major (Berl.) Can. & Kram., Demod. und Sarc., p. 98 (1889).

Described from specimens taken off *Ortygometra porzana* (spotted crake).

5. **Mégninia ibidis** Trouessart.

M. ibidis Trt., *Bull. Soc. Étud. Sci. Angers*, XIV, p. 51 (1885).

M. ibidis (Trt.) Can. & Kram., Demod. und Sarc., p. 93 (1899).

Described from specimens taken off glossy ibis, *Plegadis falcinellus (= Ibis falcinellus).*

6. **Mégninia pavonis** Oudemans.

Mégninia pavonis Oudms., *Ent. Bericht.*, No. 21, p. 210 (1905).

Described from specimens taken off *Pavo cristatus* (peacock).

Genus Analges Nitzsch.

Analges Nitzsch in Ersch and Gruber, All. Enc. Wissensch. u Kün. I (1818).

Genotype: *Acarus chelopus* Hermann.

1. **Analges bidentatus** Giebel.

Analges bidentatus Giebel, *Zeit. Naturw.*, XXXVII, p. 496 (1871).

Analges bidentatus (Gie.) Can. & Kram., Demod. und Sarc., p. 87 (1899).

Recorded taken off the migrant, *Acrocephalus arundinaceus* (great reed warbler) and other Passerines in Europe.

2. **Analges bifidus** (Nitzsch).

Acarus bifidus Nitzsch in Ersch. & Gruber, All Encl. Wissensch. u Kün., 1, p. 250 (1818).

Analges bifidus (Nitz.) Can. & Kram., Demod. und Sarc., p. 90 (1899).

Recorded taken off domestic pigeons in Europe.

Genus PTERALLOPTES Trouessart and Mégnin.

Pteralloptes Trt. and Mégn., *Compt. rend hebd. Séan. Acad. des Sci.* Paris, V, 98, p. 156 (1884).

Analloptes Trouessart, *Bull. Soc. Étud. Sci. Angers*, XIV, p. 59 (1885).

Genotype: *Dermalcichus stellaris* Buchholz.

1. **Pteralloptes mégnini falcinelli** (Trouessart).

Analloptes mégnini falcinelli Trt., *Bull. Soc. Étud. Sci. Angers*, XIV, p. 60 (1885).

Pteralloptes mégnini falcinelli (Trt.) Can. & Kram., Demod. und Sarc., p. 104 (1899).

Described from specimens taken off glossy ibis, *Plegadis falcinellus (= Ibis falcinellus).*

2. **Pteralloptes stellaris** (Buchholz).

Dermalcichus stellaris Buchh., *Bemerk.*, p. 51, Pl. 6, f. 37, 38 (1869).

Analloptes stellaris (Buchh.) Berlese, Acari, Myr. et Scorp. Ital. fasc. 38, No. 1 (1886).

Pteralloptes stellaris (Buchh.) Can. & Kram., Demod. und Sarc., p. 103 (1899).

Described from specimens taken off *Botaurus stellaris* (bittern).

3. **Pteralloptes trifolium** (Trouessart).

Analloptes trifolium Trt., *Bull. Soc. Étud. Sci. Angers*, XXVIII, p. 32 (1899).

Pteralloptes trifolium (Trt.) Can. & Kram., Demod. und Sarc., p. 103 (1899).

Described from specimens taken off long-tailed widowbird, *Diatropura procne (= Chera procne).*

Genus XOLALGES Trouessart.

Xolalges Trouessart, *Bull. Soc. Étud. Sci. Angers*, XIV, p. 61 (1885).

The following species is the genotype:—

1. **Xolalges scaurus** (Trouessart).

X. scaurus Trt., Bull. Soc. Etud, Sci. Angers, XIV, p. 42 (1885).

X. scaurus Trt., Bull. Soc. Étud. Sci. Angers, XIV, p. 42 (1885).

Described from specimens taken off *Cuculus canorus* (European cuckoo).

Subfamily PROCTOPHYLLODINAE.

This subfamily comprises nine genera.

Key to the South African Genera.

Males.

1. Third and fourth pairs of legs subequal in thickness 2
   Third and fourth pairs of legs unequal in thickness 4
2. Abdomen bilobed, the lobes united ... ... *Tronessartia*, p. 264.
   Abdomen bilobed, the lobes free 3
3. Penis long and slender ... ... *Pterodectes*, p. 264.
   Penis very small ... ... *Pterophagus*, p. 265.
4. Third pair of legs more dilated than fourth pair *Allanalges*, p. 263.
   Fourth pair of legs more dilated than third pair *Alloptes*, p. 262.

Females.

1. Abdominal lobes articulated with abdomen 2
   Abdominal lobes not articulated with abdomen 3
2. Epigynium horseshoe-shaped ... ... *Pterodectes*, p. 264.
   Epigynium absent ... ... *Pterophagus*, p. 265.
3. Abdominal lobes very elongated 4
   Abdominal lobes short ... ... *Alloptes*, p. 262.
4. Third and fourth pairs of legs equally developed *Allanalges*, p. 263.
   Fourth pair of legs slightly longer and broader than third pair ... ... *Tronessartia*, p. 264.

Genus ALLOPTES Canestrini.

Alloptes Canestrini *Atti. Soc. Veneto-Trent. Sci. Nat.*, Pavoda, VI, p. 34 (1879).

This genus contains about thirty-four species.

Genotype: *Dermaleichus crassipes* Canestrini.

1. **Alloptes bisetatus** Haller.

A. bisetatus Haller, *Zeit. für Wissensch. Zool.*, XXXVI, p. 377, Pl. 25, f. 1, 2 (1881).

A. bisetatus (Hall.) Can. & Kram., Demod. und Sarc., p. 114 (1899).

Recorded taken off *Sterna hirundo* (common tern) and sandwich tern, *Thalasseus sandvicensis (= Sterna cantiaca).*

2. **Alloptes crassipes** (Canestrini).

Dermaleichus crassipes Can., *Atti. Real. Ist. Veneto Sci.*, Lett. ed Art. (5), V. p. 68 (1878).

Alloptes crassipes (Can.) Can. & Kram., Demod. und Sarc., p. 113 (1899).

Recorded taken off black-tailed godwit, *Limosa limosa (= L. melanura)* and ruff, *Philomachus pugnax (= Tringa pugnax).*

2A. **Alloptes crassipes conura** Trouessart.

A. crassipes var. conura Trt., *Bull. Soc. Étud. Sci. Angers,* XIV, p. 68 (1885).

A. crassipes var. conura (Trt.) Can. & Kram., Demod. und Sarc., p. 113 (1899).

This variety has been found on the same hosts as the type.

2B. **Alloptes crassipes myosura** Trouessart.

A. crassipes var. myosura Trt., *Bull. Soc. Étud. Sci. Angers,* XIV, p. 69 (1885).

A. crassipes var. myosura (Trt.) Can. & Kram., Demod. und Sarc., p. 113 (1899).

Described from specimens taken off *Dromas ardeola* (crab plover).

3. **Alloptes cypseli** Canestrini and Berlese.

A. cypseli Can. & Berl., *Atti. Soc. Veneto-Trent. Sci. Nat.,* VII, p. 147, Pl. 19, f. 3, 4 (1881).

A. cypseli (C. & B.) Can. & Kram., Demod. und Sarc., p. 114 (1899).

Described from specimens taken off European swift, *Micropus apus (= Cypselus apus).*

4. **Alloptes discosurus** Trouessart.

A. discosurus Trt., *Bull. Soc. Étud. Sci. Angers, XVI, p.* 142 (1886).

A. discosurus (Trt.) Can. & Kram., Demod. und Sarc., p. 112 (1899).

Described from specimens taken off Peter's finfoot, *Podica petersi (= P. senegalensis).*

5. **Alloptes gambettae** Oudemans.

Alloptes gambettae Oudms., *Ent. Bericht.,* No. 20, p. 195 (1904).

Described from a ♂ taken off *Totanus totanus* (redshank), India.

Genus Allanalges Trouessart.

Allanalges Trouessart, *Bull. Soc. Étud. Sci. Angers,* XVI, p.137 (1886).

Genotype: *Pterocolus analgoides* Trouessart.

1. **Allanalges analgoides** (Trouessart).

Pterocolus analgoides Trt., *Bull. Soc. Étud. Sci. Angers,* XIV, p. 76 (1885).

Allanalges analgoides (Trt.) Can. & Kram., Demod. und Sarc., p. 116 (1899).

Described from specimens taken off *Merops apiaster* (European bee-eater).

2. **Allanalges podagricus** Trouessart.

A. podagricus Trt., *Bull. Soc. Étud. Sci. Angers*, XVI, p. 137 (1886).

A. podagricus Can. & Kram., Demod. und Sarc., p. 115 (1899).

Described from specimens taken off southern emerald cuckoo, *Chrysococcyx intermedius sharpei (= C. smaragdineus).*

Genus Trouessartia Canestrini.

Pterocolus Haller, 1878, *nec Schoenherr*, 1833.

Trouessartia Canestrini, in Can. and Kram., Demod. und Sarc., p. 119 (1899).

Genotype: *Dermaleichus corvinus* C. L. Koch.

1. **Trouessartia appendiculata appendiculata** (Berlese).

Pterocolus appendiculatus Berl., Acari, Myr. et Scorp in Ital. (V), No. 27 (1884).

Trouessartia appendiculata (Berl.) Can. & Kram., Demod. und Sarc., p. 121 (1899).

Recorded taken off European sandmartin, *Riparia riparia (= Cotyle riparia)* and European swift, *Micropus apus (= Cypselus apus).*

1a. **Trouessartia appendiculata minutipes** (Berlese).

Pterocolus appendiculatus var. minutipes Berl., Acari, Myr. et Scorp. in Ital., fasc. 26, No. 4 (1884).

Trouessartia appendiculata var. minutipes Can. & Kram., Demod. und Sarc., p. 121 (1899).

Described from specimens taken off house martin, *Chelidonaria urbica (= Chelidon urbica).*

2. **Trouessartia corvina rosteri** (Berlese).

Pterocolus corvina var. rosteri Berl., Acari, Myr. et Scorp in Ital., fasc. 26, No. 2 (1883).

Trouessartia corvina var. rosteri Can. & Kram., Demod. und Sarc., p. 121 (1899).

This variety has been found on *Sturnus vulgaris* (starling) in Europe, and probably occurs on this host at Capetown, C.P.

Genus Pterodectes Robin.

Pterodectes Robin, *Comp. rend. Séan. et Mém. Soc. de Biol.*, LXVI, p. 786 (1868).

Twenty-five species are included in this genus.

Genotype: *Pterodectes rutilus* Robin.

1. **Pterodectes bilobatus** Robin.

P. bilobatus Robin, *Comp. rend. Séan. et. Mém. Soc. de Biol.*, LXVI, p. 786 (1868).

P. bilobatus (Rob.) Can. & Kram., Demod. und Sarc., p. 124 (1899).

Described from specimens taken off European tree pipit, *Spipola trivialis (= Anthus trivialis).*

2. **Pterodectes gynurus** (Trouessart).

Alloptes gynurus Trt., *Bull. Soc. Étud. Sci., Angers*, XVI, p. 145 (1886).

Pterodectes gynurus (Trt.) Can. & Kram., Demod. und Sarc., p. 125 (1899).

Described from specimens taken off Egyptian goose, *Alopochen aegyptiacus (= Chenalopex aegyptiacus).*

3. **Pterodectes megacaulus** (Trouessart).

P. megacaulus Trt., *Bull. Soc. Étud. Sci., Angers*, XIV, p. 80 (1885).

P. megacaulus (Trt.) Can. & Kram., Demod. und Sarc., p. 125 (1899).

Described from specimens taken off greater double-collared sunbird, *Notiocinnyris afer (= Nectarinia afra).*

4. **Pterodectes ortygometrae** (Canestrini).

Dermaleichus ortygometrae Can., *Atti. Real. Ist. Veneto Sci.* Lett. ed Art (V), p. 58 (1878).

Pterodectes ortygometrae (Can.) Can. & Kram., Demod. und Sarc., p. 122 (1899).

Recorded taken off *Ortygometra porzana* (spotted crake).

4a. **Pterodectes ortygometrae furcifer** (Trouessart).

Pterocolus ortygometrae var. furcifer Trt., *Bull. Soc. Étud. Sci. Angers*, XIV, p. 73 (1885).

Pterodectes ortygometrae var. furcifer (Trt.) Can. & Kram., Demod. und Sarc., p. 122 (1899).

Described from specimens taken off two-banded courser, *Smutsornis africanus (= Cursorius bicinctus).*

5. **Pterodectes rutilus** Robin.

P. rutilus Robin, *Compt., rend. Séan. Mém. Soc. Biol.*, LXVI, p. 786 (1868).

P. rutilus (Robin.) Can. & Kram., Demod. und Sarc., p. 124 (1899).

Described from specimens taken off house martin, *Chelidonaria urbica (= Hirundo urbica).*

Genus Pterophagus Robin and Mégnin.

Pterophagus Robin & Mégnin, *Journ. Anat. et Physiol.*, XIII, p. 652 (1877).

This genus contains a single species.

1. **Pterophagus strictus** Mégnin.

P. strictus Mégnin, *Journ. Anat. et Physiol.*, XIII, p. 653, Pl. 37, f. 1-5 (1877).

♂, ♀. *P. strictus* (Mégn.) Can. & Kram., Demod. und Sarc., p. 128 (1899).

This species occurs on domestic pigeons, and has also been recorded from other pigeons in Europe.

Subfamily EPIDERMOPTINAE.

Key to the South African Genera (after Canestrini and Kramer).

1. Suckers massive ... ... *Heteropsorus.*
   Suckers normal; small; legs of ♂ and ♀ evenly developed ... 2
2. Legs with claws ... ... *Epidermoptes.*
   Legs without claws ... ... *Rivoltasia.*

Genus HETEROPSORUS Trouessart and Neumann.

Heteropsorus Trt. and Neu., *Bull. Soc. Étud. Sci., Angers*, XVII, p. 137 (1887).

This genus comprises a single species.

1. **Heteropsorus pteroptopus** Trouessart and Neumann.

H. pteroptopus Trt. & Neu., *Bull. Soc. Étud. Sci. Angers*, XVII, p. 137, Pl. 2, f. 1 (1887).

H. pteroptopus (T. & N.) Can. & Kram., Demod. und Sarc., p. 129 (1899).

Recorded taken off *Acrocephalus arundinaceus* L. (great reed warbler). The type host is *Cyanecuta suecica.*

Genus EPIDERMOPTES RIVOLTA.

Epidermoptes (part) Rivolta, *Giorn. Anat. Fisiol.*, VIII, i (1876).

This genus contains a single species. It is minute, weakly chitinized, and lives on the skin of its host.

1. **Epidermoptes bilobatus** Rivolta.

E. bilobatus Rivolta, *Giorn. Anat. Fisiol.*, VIII, i (1876).

E. bilobatus (Riv.) Can. & Kram., Demod. und Sarc., p. 129 (1899).

This species was described from specimens taken off the domestic fowl in Europe. It probably occurs in South Africa.

2. **Epidermoptes pterolichus uncinatus** (Mégnin).

P. uncinatus Mégnin, *Jour. Anat. et Physiol.*, XIII, p. 420 (1877).

P. (Eupterolichus) uncinatus (Mégn.) Can. & Kram., Demod. und Sarc., p. 45 (1899).

Described from specimens taken off paradise widow-bird *Steganura paradisea (= Vidua paradisea).*

Genus Rivoltasia Canestrini.

Rivoltasia Canestrini, *Prosp. Acarof.*, VI, p. 823 (1894).

This is a small genus comprising three species and one variety. The following is the genotype:—

1. **Rivoltasia bifurcata** (Rivolta).

Epidermoptes bifurcatus Rivolta, *Giorn. Anat. Fisiol.*, VIII, p. 247 (1876).

Rivoltasia bifurcata (Riv.) Can. & Kram., Demod. und Sarc., p. 130 (1899).

This minute, weakly chitinized species has been found living on the skin of the domestic fowl in Europe. It probably occurs in South Africa.

Family LISTROPHORIDAE.

This family includes a number of species living in the fur of various animals. At least two known species probably occur in South Africa, namely, *Listrophorus gibbus* Pagenstecher, and *Campylochirus caviae* Hirst (= *Chirodiscoides caviae*), which live respectively in the fur of rabbits and guinea-pigs.

Suborder BRACHYPODA (VERMIFORMIA).

Superfamily DEMODICOIDEA.

Family DEMODICIDAE.

The mites included in this family are extremely small and very elongate. They live in the sebaceous sacs and hair-follicles of various kinds of mammals.

Genus Demodex Owen.

Demodex Owen, *Lect. invert. An.*, p. 252 (1843).

Demodex (Owen) Hirst, Stud. on Acari, No. 1, p. 12 (1919).

Hirst in his monograph of this genus lists 16 species. One species, *Demodex folliculorum* (Simon), is a common parasite of man in Europe, and probably also occurs in this country.

1. **Demodex bovis** Stiles.

D. folliculorum var. bovis Stiles, *Canad. Ent.*, XXIV, p. 286 (1892).

D. bovis (Stiles) Hirst, *Stud. on Acari*, No. 1, p. 28, Pl. 1, f. 6; Pl. 2, f. 7, 8; Pl. 5, f. 25, 26; Pl. 6, f. 30 (1919).

This species has been recorded from cattle in Europe, America and the Belgian Congo. We have received specimens taken from cattle in Northern Rhodesia, Tanganyika and Angola. It probably occurs in the Union.

2. **Demodex canis** Leydig.

D. canis Leydig, *Arch. Naturg. Jahrg.* i, XXV, p. 345 (1859).

D. canis (Leydig) Hirst, *Stud. on Acari*, No. i, p. 23, Pl. 1, f. 4, 5 (1919).

This species has been found in dogs at Onderstepoort, near Pretoria.

3. **Demodex caprae** Railliet.

D. folliculorum var. caprae Railliet, *Zool. Méd. Agric.* 2nd Ed., p. 638 (1895).

D. caprae (Railliet) Hirst, *Stud. on Acari*, No. 1, p. 38 (1919).

This species has been found in a goat at Pretoria.

4. **Demodex phylloides** Csokor.

D. phylloides Csokor, *Oest. Vierteljahrschr. f. Veterinärk.* LI, p. 133 (1879).

D. folliculorum var. suis Railliet, *Zool.* Ed. 2, p. 637 (1895).

D. phylloides (Csokor) Hirst, *Stud. on Acari*, No. 1, p. 27, Pl. 5, f. 22, 24 (1919).

This species has been found in pigs at Onderstepoort, near Pretoria.

Suborder PROSTIGMATA.

Superfamily TROMBIDOIDEA.

Key to the Families.

1. Chelicerae usually either styletiform or needle-like, not falcate ... ... Cheyletidae.

Chelicerae falcate, not needle-like ... ... Trombidiidae.

Family CHEYLETIDAE.

The mites belonging to this family are either predaceous or parasitic. The palpi are well developed and move in a horizontal direction, and in the predaceous species they are armed with either comb-like structures or strong, curved setae.

Genus Cheyletiella Canestrini (1886).

1. **Cheyletiella parasitivorax** (Mégnin) 1878.

This species has been found on domestic rabbits at Onderstepoort. It is said to be predaceous on *Listrophorid* mites, and is the only species of the genus known to occur on mammals.

Genus Syringophilus Heller, 1880.

This genus includes a few species living inside the quills of birds. The body is very elongated. The legs are all similar, and possess a pair of comb-like pulvilli and two claws.

1. **Syringophilus bipectinatus** Heller, 1880.

S. bipectinatus (Heller) Hirst, Mites Injur. to Domest. Anim., p. 74, f. 41a, 42a (1922).

This species has been found in the quills of domestic fowls in both Europe and North America.

2. **Syringophilus columbae** Hirst, 1920.

S. columbae Hirst, Mites Injur. to Domes. Animal., p. 75, f. 41B, 42B (1922).

Described from specimens found in the quills of domestic pigeons.

3. **Syringophilus helleri** Oudemans.

♀, ○, L. *S. helleri* Oudms., *Ent. Bericht.*, No. 20, p. 190 (1904).

Described from specimens taken off green sandpiper, *Tringa erythropus* (= *Totanus ochropus*) in Europe.

4. **Syringophilus totani** Oudemans.

♀, ○. *S. totani* Oudms., *Ent. Bericht.*, No. 19, p. 171 (1904).

Described from specimens taken off *Totanus totanus* (redshank).

Genus Cheletoides Oudemans.

Cheletoides Oudemans, *Ent. Bericht.*, No. 18, p. 163 (1904).

Similar to *Cheletes*, but with only one palpal comb and with one anterior dorsal shield.

Genotype: *Cheletes nörneri* Poppe.

1. **Cheletoides uncinata** (Heller, 1880).

This species has been found in the quills of *Pavo cristatus* (peacock).

Genus Cheletopsis.

1. **Cheletopsis anax** Oudemans.

♂, ♀, ○. *C. anax* Oudms., *Ent. Bericht.*, No. 19, p. 170 (1904).

Described from specimens taken off *Totanus totanus* (redshank).

2. **Cheletopsis animosa** Oudemans.

♂, ♀. *C. animosa* Oudms., *Ent. Bericht.*, No. 19, p. 170 (1904).

Described from specimens taken off *Totanus totanus* (redshank).

3. **Cheletopsis basilica** Oudemans.

♀. *C. basilica* Oudms., *Ent. Bericht.*, No. 19, p. 170 (1904).

Described from specimens taken off *Totanus totanus* (redshank).

4. **Cheletopsis impavida** Oudemans.

♂, ♀, ○. *C. impavida* Oudms., *Ent. Bericht.*, No. 19, p. 170 (1904).

Described from specimens taken off *Totanus totanus* (redshank).

Genus Sarcopterinus Railliet, 1893.

1. **Sarcopterinus nidulans** (Nitzsch, 1818).

This species has been recorded from a number of birds, including pigeons. It lives in colonies in the follicles of the feathers, and gives rise to tumours or cysts in the skin.

Family TROMBIDIIDAE.

This family includes the harvest mites. They are the largest mites known, and are usually of a brilliant scarlet colour. The adults and nymphs are free living and predaceous, but their larvae are invariably parasitic upon insects and other arthropods and vertebrates.

Genus Trombicula Berlese.

The adults can be distinguished by having the body greatly constricted in front of the middle, and the larvae have only five setae on the dorsal plate in addition to the pseudostigmatic organs which are flagelliform and pectinate, and each chelicera bears only one dorsal tooth. Several species are known to be parasitic in their larval stage upon man and various animals. One species, probably *T. autumnalis* (Shaw), has been found on sheep and horses in the Transvaal; also on cattle and horses at Stellenbosch, C.P. (J. F. Dunning).

Genus Leeuwenhoekia Oudemans.

Leeuwenhoekia Oudemans, *Ent. Ber.*, p. 137 (1911).

The larvae have six setae on the dorsal plate in addition to the pseudo-stigmatic organs.

1. **Leeuwenhoekia polydiscum** (Oudemans).

Heterothrombidium polydiscum Oudemans, *Ent. Ber.*, p. 105 (1910).

Described from specimens taken off *Hipposideros caffer* at Durban, Natal.

Genus Microtrombidium Haller.

1. **Microtrombidium minutissimum** Oudemans.

Microtrombidium minutissimum Oudemans, *Ent. Ber.*, p. 104 (1910).

Described from specimens taken off *Hipposideros caffer* at Durban, Natal.

Genus Typhlothrombium *Berlese.*

Typhlothrombium Berlese, *Redia*, p. 358 (1910).

1. **Typhlothrombium nanus** Oudemans.

Typhlothrombium nanus Oudemans, *Ent. Ber.*, p. 105 (1910).

Described from specimens taken off *Hipposideros caffer* at Durban, Natal.

Suborder MESOSTIGMATA.

Key to the Superfamilies.

1. Hypostome small or absent, never with recurved teeth; tracheae usually opening through chitinous tubes or peritremes; sternal plate usually present
PARASITOIDEA

Hypostome large and provided with recurved teeth; tracheae opening through a chitinous plate; sternal plate usually absent ... ... IXODOIDEA, p. 275.

Superfamily PARASITOIDEA.

Key to the Families.

1. Chelicerae with the apices incurved and provided with teeth, and the fixed arm usually with a seta at the apex; body usually well covered with chitinous plates; anal plate, if present, usually united with ventral plate in both sexes ... ... PARASITIDAE, p. 273.

Chelicerae usually without teeth and fixed arm always without seta; body usually only partly covered on dorsum and venter with chitinous plates; anal plate nearly always present and distinct from ventral plate in ♀♀.
DERMANYSSIDAE, p. 271.

Family DERMANYSSIDAE.

This family includes a number of species. They are all parasitic upon mammals, birds and reptiles.

Key to the South African Genera.

1. Stigmata situated dorsally. Parasitic upon birds
Rhinonyssus.

Stigmata situated laterally 2

2. Chelicerae, at least in ♀, with teeth, and with movable arm; dorsal plate undivided; anal plate very large with numerous setae ... ... *Myonyssoides.*

3. Chelicerae of ♀ shear-like, with both arms present; anal plate usually egg-shaped; dorsal plate of ♀ entire; sternal plate with 3 pairs of setae ... ... *Liponyssus.*

Chelicerae of ♀ long and needle-like; anal plate not egg-shaped with anal opening on its posterior part; dorsal plate of ♀ entire ... ... *Dermanyssus.*

Subfamily RHINONYSSINAE.

Genus Rhinonyssus Trouessart.

1. **Rhinonyssus coniventris** Trouessart.

Rhinonyssus coniventris (Trouess.) Hirst, *Proc. Zool. Soc. Lond.*, p. 361, f. 6, 7 (1921).

Recorded by Hirst (1921) taken in the nasal cavities of turnstone, *Arenaria interpres (= Strepsilas interpres)*, a migrant to South Africa.

2. **Rhinonyssus echinipes** Hirst.

Rhinonyssus echinipes Hirst, *Proc. Zool. Soc. Lond.*, p. 359, f. 3, 4 (1921).

Described from specimens collected in the nasal cavities of ringed plover, *Charadrius hiaticula (= Aegialitis hiaticula)* in the Shetland Isles. The host is a migrant to South Africa.

Subfamily IXODORHYNCHINAE.

Genus *Myonyssoides* Hirst.

Myonyssoides Hirst, *Proc. Zool. Soc. Lond.*, Pt. 1, p. 49 (1925).

This genus includes a single species.

1. **Myonyssoides capensis** Hirst (Fig. 4A and D).

Myonyssoides capensies Hirst, *Proc. Zool. Soc. Lond.*, Pt. 1, p. 49, f. 1 (1925).

Described from numerous specimens taken off *Cryptomys hottentotus* (Hottentot mole-rat) at Grahamstown, C.P.

Subfamily LIPONYSSINAE.

Genus Liponyssus Kolenati (1859).

1. **Liponyssus bacoti** (Hirst) Fig. 4B.

♀. *Leiognathus bacoti* Hirst, *Bull. Ent. Res.*, IV, p. 122 (1913).

♀, ♂. *Leiognathus bacoti* Hirst, *ibid.*, V, p. 225, f. 12, 13 (1914).

Recorded by Hirst (1925) as attacking man at Pretoria and Weenen, Natal. It is normally parasitic on rats, and is widely distributed in the warmer parts of the world. It was orginally described from Egypt.

2. **Liponyssus bursa** Berlese (1888).

This species, known as the "tropical read mite", is a serious pest of poultry in South Africa. They are blood-suckers and attack their hosts chiefly at night. In "*The External Parasites of Poultry, with Measures for their Control*" this parasite was erroneously recorded under the name of *Dermanyssus gallinae*.

Subfamily DERMANYSSINAE.

Genus Dermanyssus Dugés (1834).

This genus includes five species, two being found on birds and three on rats.

1. **Dermanyssus gallinae** (Redi), 1674 (Fig. 4c).

Recorded by Hirst (1925) attacking man at Capetown. This species is a common red mite of poultry and cage birds in Europe and North America.

Family PARASITIDAE.

This family, formally known as *Gamasidae*, includes a very large number of species found in all parts of the world. A large number of them are free-living mites, but many species are parasitic on vertebrates and invertebrates.

Key to the Subfamilies.

1. Spiracles dorso-lateral in position; legs short, stout and with large caruncles; larval stage passed inside the body of ♀. Parasitic mainly on bats ... ... *Spinturnicinae.*

Spiracles ventro-lateral in position; legs more slender, with moderate caruncles; first pair of legs with either claws or caruncle and usually ambulatory in function *Parasitinae.*

Subfamily SPINTURNICINAE.

This family includes a number of species belonging to the genera *Ancystropus* Kolenati, *Spinturnix* Heyden and *Periglischrus* Kolenati. The majority of the species have been found on bats in Europe and Africa, but no species has so far been recorded from South Africa.

Subfamily PARASITINAE.

Key to the South African Genera.

1. Second pair of legs enlarged and calcarate in both sexes. *Androlaelaps.*

Second pair of legs not calcarate in either sex 2

2. Setae on fixed digit of chelicerae very long and filiform *Haemolaelaps.*

Setae on fixed digit of chelicerae not so; genito-ventral plate with four pairs of setae, not extending to anal plate; second pair of legs not greatly enlarged, ... *Laelaps.*

Genus Androlaelaps Berlese.

Androlaelaps Berlese, *Zool. Anz.*, XXVII, p. 14 (1903).

1. **Androlaelaps sp.**

Ingram (1927) records specimens from *Pedetes caffer* (spring-hare), Bainsvlei, Kroonstad District, O.F.S.

Genus HAEMOLAELAPS.

1. **Haemolaelaps capensis** Hirst.

Haemolaelaps capensis Hirst, *Jour. Zool. Res., Lond.*, I, ii, p. (1916).

Described from specimens taken off Hottentot mole-rat, *Cryptomys hottentotus (= Georychus hottentotus)* from Cape Province.

2. **Haemolaelaps sp.**

Recorded by Ingram (1927) from *Tatera lobengulae* (gerbille), in the Frankfort, Kroonstad and Heilbron Districts, O.F.S.; also from *Geosciurus capensis* (ground squirrel) at Rendezvous, O.F.S.; and from *Pedetes caffer* (springhare), Bainsvlei, O.F.S.

Genus LAELAPS Koch.

Hirst gives a key to the females in the *Proc. Zool. Soc., Lond.*, Pt. 1, p. 53 (1925).

1. **Laelaps giganteus giganteus** Berlese (Fig. 3).

Laelaps giganteus Berlese, *Redia*, XIII, pp. 129-131 (1918).

Laelaps giganteus (Berl.) Hirst, *Proc. Zool. Soc. Lond.*, Pt. 1, pp. 66, 67, f. 13 (1925).

Recorded by Hirst (1925) from bushveld striped mouse, *Lemniscomys spinalis (= Arvicanthis dorsalis)*, Mfongosi, Zululand. It has also been recorded taken off various rodents in Uganda, Kenya Colony, Nigeria and Liberia.

1A. **Laelaps giganteus bakeri** Hirst.

Laelaps giganteus var. bakeri Hirst, *Proc. Zool. Soc. Lond.*, Pt. 1, pp. 67-69, f. 14 (1925).

Recorded by Hirst (1925) taken off striped mouse, *Rhabdomys pumilio (=Arvicanthis pumilio)* at Bothaville, O.F.S., and Grahamstown, C.P.; also from *Rattus rattus rattus* in Kenya Colony, and from various rodents in Uganda and Algeria.

2. **Laelaps muricola** Trägardh (Fig. 4E).

Laelaps muricola Träg., *Wirs. Ergebn. Schwed. Zool. Exp. Kilimand.*, III, pp. 54-57 (1910).

Laelaps muricola (Träg.) Hirst, *Proc. Zool. Soc. Lond.*, Pt. 1, pp. 63-64, f. 11 (1925).

Hirst (1925) records specimens taken in South Africa off multimammate mouse, *Mastomys coucha (= Mus coucha)* and *M. coucha silaceus*, Grahamstown, C. P. Ingram (1927) recorded it from *Tatera lobengulae* (gerbille), Frankfort, Kroonstad and Heilbron Districts, O.F.S.; *Rhabdomys pumilio* (striped mouse), Standerton, Transvaal, and *Mastomys coucha*. It has also been found on various rodents in Uganda, Kenya Colony, N. Nyasa, Gold Coast, Nigeria and Abyssinia.

3. **Laelaps parvulus** Hirst

Laelaps parvulus Hirst, *Proc. Zool. Soc., Lond.*, Pt. 1, pp. 54-55, f. 3 (1925).

Hirst (1925) records specimens taken in South Africa off bushveld striped mouse, *Lemniscomys spinalis* (= *Arricanthis dorsalis*); also from *Otomys irroratus* (African water rat) at Grahamstown, C.P.

4. **Laelaps vansomereni** Hirst

Laelaps vansomereni Hirst, *Proc. Zool. Soc. Lond.*, Pt. 1, pp. 55-56, f. 4 (1925).

Hirst (1925) records specimens taken off African rat, *Aethomys chrysophilus* (= *Mus chysophilus*) at Mfongosi, Zululand; also from rodents in Uganda and Kenya Colony.

Superfamily IXODOIDEA (Ticks).

Ticks are sub-divided into two families, the *Argasidae*, which includes the fowl ticks and tampans, and the *Ixodidae* or true ticks. These may be differentiated as follows:—

Family ARGASIDAE.—Integument of body more or less leathery, without a hard shield (scutum). Sexual dimorphism slight, the males only being distinguishable from the females by the shape of the sexual opening. Head situated on the anterior portion of the ventral surface, and not projecting beyond the anterior margin of the body, except in the larvae. Eyes usually absent; when present, four in number and situated laterally on the supra-coxal folds. Pulvillus absent or rudimentary.

Family IXODIDAE.—Scutum present on the dorsal surface of the body, forming a small round or oval plate behind the head in the females, nymphs, and larvae, and covering the entire upper surface in the males. Head situated on the anterior margin, and always plainly visible when viewed from above. Eyes absent or present; when present, two in number, situated on the lateral margin of the scutum. Pulvillus always present.

Family ARGASIDAE Canestrini.

In the past this family has comprised two genera, *Argas* and *Ornithodoros*, the former only distinguishable from the latter in having the margin of the body differing in structure from the rest of the integument. As this character cannot be considered of generic importance, we have been compelled to sink *Ornithodoros* as a synonym of *Argas*. In 1908 Nuttall, Warburton, Cooper and Robinson stated that they were by no means sure that the family Argasidae contained more than one genus, *Argas*, and since then one or two new species have been described which support their view. In *Ornithodoros* the integument varies in different species and in some, such as *O. pérengueyi*, it more closely resembles the integument of species of *Argas* than that of other species of *Ornithodoros*, such as *moubata*, etc. Moreover, the shape of the body and other characters of *O. pérengueyi* also convince one that it is more closely related to certain species of *Argas* than it is to *O. moubata*, etc.

Fig. 6. *Argas persicus* (Oken), dorsum of female.

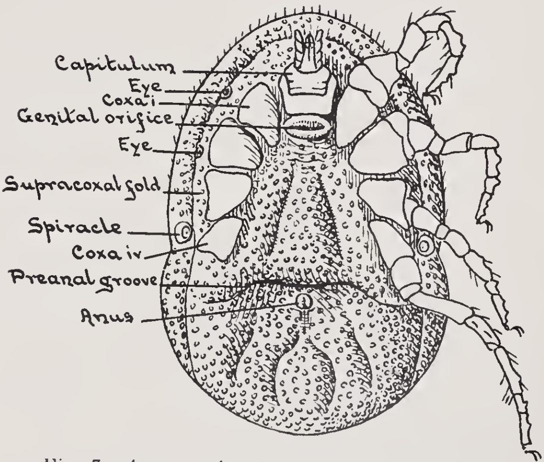


Fig. 7. *Argas savignyi* Aud., venter of female.

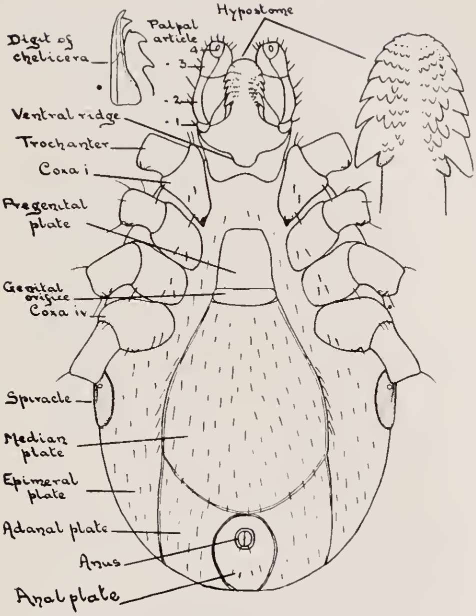


Fig. 8. *Ixodes pilosus* Koch, venter of male.

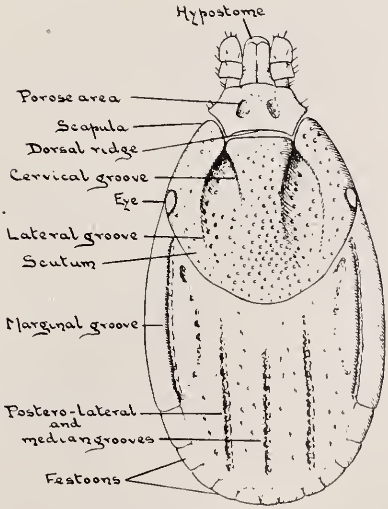


Fig. 9. *Rhipicephalus appendiculatus*, Neu., dorsum of female.

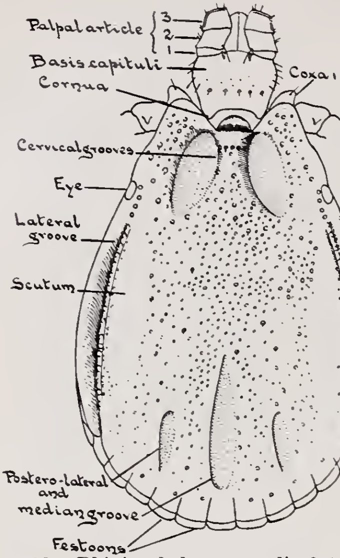


Fig. 10. *Rhipicephalus appendiculatus* Neu., dorsum of male.

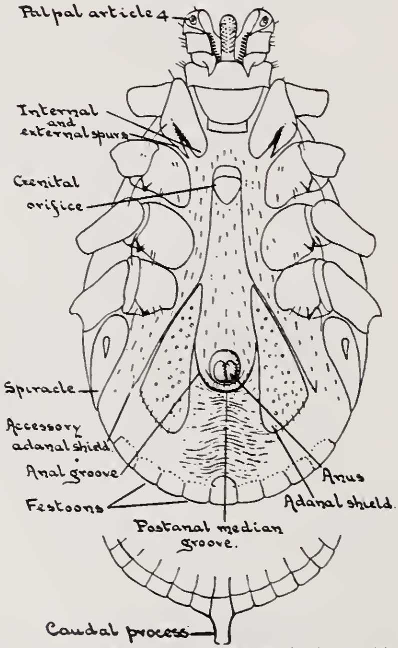


Fig. 11. *Rhipicephalus appendiculatus* Neu., venter of male.

Genus ARGAS Latreille.

Argas Latreille, *Précis Caract. Ins.*, p. 178 (1796).
Ornithodoros Koch, *Arch. f. Naturg.*, X, i, p. 219 (1844).
Argas (Latr.) Nutt., Warb., Cooper & Robinson, Ticks: Mon. Ixod., I, p. 4 (1908).
Ornithodoros (Koch) Nutt., Warb., Cooper & Robinson, *ibid.*, p. 39 (1908).
Ornithodoros of numerous authors.

This genus is cosmopolitan and contains about thirty-two species, ten of these having been recorded from South Africa.

Key to the South African Species.

1. Integument not mammillated; eyes absent 2
   Integument mammillated, usually without discs; eyes present or absent 7
2. Body circular, the anterior margin pointed in the adults *A. vespertilionis* (Latr.).
   Body oblong 3
3. Integument of adults with numerous small pits, of nymph with numerous small spines; margins similar to rest of body ... ... *A. mégnini Dugès.*
   Integument without small pits, but symmetrically arranged discs (largish depressions) present; spines absent 4
4. Anterior margin of body rounded 5
   Anterior margin of body sub-conical 6
5. Margin of body formed of a border of quadrangular plates *A. persicus* (Oken).
   Margin of body formed of a series of irregular wrinkles *A. transgariepinus* White.
6. Integument with numerous striae, the arrangement of the striae on the margins differing from those on the rest of the body; indistinct discs on dorsum; venter and posterior margin of dorsum wrinkled. *A. striatus* Bedf.
   Integument finely wrinkled, the margins being similar to the rest of the body; discs larger and more numerous *A. péringueyi* (Bedf. & Hewitt).
7. Body broad and rounded in front 8
   Body narrower, sub-conical in front; eyes absent *A. capensis* (Neu.).
8. Body with hemispherical granulations * 9
   Body with flat contiguous granulations; eyes present *A. pavimentosus* (Neu.).
9. Eyes absent ... ... *A. moubata* Murray.
   Eyes present ... ... *A. savignyi* Aud.

* In fully distended adults of *A. moubata* the granulations are flat.

1. **Argas talaje capensis** (Neumann). " The penguin tick ".

Ornithodoros talaje var. capensis Neu., *Mém. Soc. Zool. France*, XIV, p. 258 (1901).

O. talaje var. capensis (Neu.) Nutt., Warb., Cooper & Robins., Ticks: Mon. Ixod., I, p. 61, f. 58, 89 and Pl. 3 (1908).

O. talaje var. capensis (Neu.) Howard, *Ann. Trl. Mus.*, I, ii, p. 88, Pl. 1, figs. r, s; Pl. 3, figs. a-e (1908).

This tick is found in the nests of *Spheniscus demersus* (jackass penguin) on islands off the Cape Province coast. It readily attacks both man and fowls when opportunities offer.

2. **Argas mégnini** Dugès, " The spinose ear tick ".

Argas mégnini Dugès, *Naturaleza*, V, p. 195 (1883).

Ornithodoros mégnini (Dugès) Nutt., Warb., Cooper & Robins., *Mon. Ixod.*, I, pp. 71, 103, f. 102-112 (1908).

Ornithodorus mégnini (Dugès), Bedford, *Rep. Dir. Vet. Res.*, II, p. 343, Pl. 37 (1912).

This is an American tick which has established itself throughout the dry districts of the Cape Province and the Orange Free State. It also occurs in parts of Natal and has rcently been found in the Transvaal. Larvae and nymphs are only found in the ears of their hosts. They are chiefly parasitic upon cattle, sheep and goats, but also attack man, horses, donkeys, mules, dogs, cats and ostriches. The adults do not feed.

3. **Argas moubata** Murray, " The eyeless tampan tick ".

Argas moubata Murray, *Econ. Ent. Apt.*, p. 182 (1877).

Ornithodoros savignyi var. caecus Neumann, *Mém. Soc. Zool. France*, XIV, p. 256 (1901).

Ornithodoros moubata (Murray), Nutt., Warb., Cooper & Robins., Ticks: Mon. Ixod., 1, pp. 46, 96, f. 58, 66-80 (1908).

Ornithodoros savignyi var. caecus (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 86, Pl. 1, figs. a-e; Pl. 3, figs. g, h (1908).

This species has been recorded from the Cape Province, Transvaal, Bechuanaland, South-West Africa, Angola, Rhodesia, Portuguese East Africa, Congo, Somaliland, Kenya Colony, Tanganyika Territory, Zanzibar and Abyssinia. It is parasitic on man and also attacks domestic animals, rabbits, rats, mice and fowls. Adults and nymphs have also been taken off 44 tortoises (*Testudo oculifera* and *T. verreauii*), Niekerk's Hope, Kimberley, C.P. (coll. J. H. Power). It is the transmitting agent of *Treponema duttoni*, the organism which causes African relapsing fever or tick fever in man. It has also been proved experimentally to transmit *Treponema gallinarum* to fowls.

4. **Argas pavimentosus** (Neumann).

Ornithodoros pavimentosus Neu. *Mém. Soc. Zool. France*, XIV, p. 257 (1901).

Ornithodoros pavimentosus (Neu.) Nutt., Warb., Cooper & Robins., Ticks: Mon. Ixod., I, p. 62, f. 90-92 (1908).

Ornithodoros savignyi var. pavimentosus (Neu.) Howard, *Ann. Trl. Mus.*, I, ii, p. 87, Pl. 3, figs. f-h (1908).

This species, which is parasitic upon man, has only been found in South-West Africa. The type was collected at Bethany.

5. **Argas pérengueyi** (Bedford and Hewitt), "The swallow tick".

Ornithodorus pérengueyi Bedf. & Hewitt, *S. Afr. Journ. Nat. Hist.*, V, i, p. 259, Pl. 19, f. 1-3 (1925).

Described from adults and one nymph taken at Nqamakwe, C.P. They were collected by the Rev. L. S. Byrde, who reported on them as infesting a native church. I have since taken adults and immature forms in the nests of *Petrochelidon spilodera* (South African cliff swallow) at Onderstepoort.

6. **Argas persicus** (Oken), "The fowl tick" (Fig. 6).

Rhynchoprion persicum Oken, *Isis*, p. 1567, Pl. 19, f. 1-4 (1818).

Argas persicus (Oken) Nutt., Warb., Cooper & Robins., Ticks: Mon. Ixod., I, pp. 8, 81, Pl. 1, f. 3 & f. 1-26 (1908).

Argas persicus (Oken) Howard, *Ann. Trl. Mus.*, I, ii, p. 76, Pl. 1, figs. f-i; Pl. 2, figs. c-n (1908).

This tick is very common throughout the country, and is the most serious pest the poultry-keeper has to contend with. It has also been recorded from Southern Rhodesia, Mozambique, Belgian Congo, Egypt, Sudan, Algeria, Mauritius, Russia, Turkestan, Persia (type locality), India, China, the southern part of North America, South America and Australia. It is parasitic upon fowls, ducks, geese, turkeys, pigeons, canaries and ostriches. Howard (1908) has also recorded it from secretary bird *(Sagittarius serpentarius)* and specimens have also been taken off wild guinea-fowl *(Numida papillosa transvaalensis)* at Pienaars River, Transvaal. It has frequently been known to attack man in Persia, but rarely does so in South Africa. The ticks live mainly in the cracks and crevices of woodwork of fowl-houses and runs, and under the bark of trees. They mainly attack their hosts at night, except the larvae, which remain on their hosts for several days to feed. The fowl tick is the chief transmitting agent of the fowl spirochaete *(Treponema gallinarum)*, which is usually fatal to birds.

7. **Argas savignyi** Audouin. " The tampan tick " (Fig. 7).

Argas savignyi Aud., *Descr. Egypte*, ed. 2, XXII, p. 426, Pl. 9, f. 5 (1827).

Ornithodoros savignyi (Aud.) Nutt., Warb., Cooper & Robins., Ticks: Mon. Ixod., I, p. 42, Pl. 2 and f. 58, 59-65, 70, 71 (1908).

Ornithodoros savignyi (Aud.) Howard, *Ann. Trl. Mus.*, I, ii, p. 83 (1908).

This tick is widely distributed in Africa, it having been recorded from the Cape Province, Transvaal, Bechuanaland, South-West Africa, Rhodesia, Portuguese East Africa, Tanganyika Territory, Congo, Somaliland, Abyssinia and Nubia. It is found in desert tracts in the shade of trees and rocks, and also in native huts. It is parasitic upon man and fowls, and has also been reported to feed on dogs, horses, sheep, goats, cattle, pigs and rabbits. Two adults were found by the Verney-Lang Expedition to the Kalahari on sandy ground at Damara Pan, 1930.

8. **Argas striatus** Bedford.

Argas striatus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVIII, p. 221, f. 1-2 (1932).

Described from three females found in the nest of *Philetairus socius* (sociable weaver), Kenhardt, C.P.

9. **Argas transgariepinus** White.

Argas transgariepinus White in Methuen, *Life in S. Afr.*, p. 318, Pl. 2, f. 4 (1846).

Argas kochi Neumann, *Mém. Soc. Zool. France*, XIV, p. 254 (1901).

A. transgariepinus (White) Nutt., Warb., Cooper & Robins., Ticks: Mon. Ixod., I, p. 29, f. 36, 37 (1908).

A. transgariepinus (White) Howard, *Ann. Tvl. Mus.*, I, ii, p. 81 (1908).

Described from three females which were probably collected north of the Orange River. The type of *A. kochi*, *a* ♂, was collected in Basutoland. The host is unknown.

10. **Argas vespertilionis** (Latreille), " The bat tick ".

Carios vespertilionis Latr., *Précis Caract. Ins.*, p. 177 (1796).

A. vespertilionis (Latr.) Nutt., Warb., Cooper & Robins., Ticks: Mon. Ixod., I, p. 34, Pl. 1, f. 4, 5 and figs. 48-57 (1908).

A. vespertilionis (Latr.) Howard, *Ann. Trl. Mus.*, I, ii, p. 79, Pl. 1, figs. h-p; Pl. 2, figs. p-w (1908).

Recorded from various species of bats in South Africa, Egypt, Tunis, England and France. Howard (1908) recorded it from *Miniopterus natalensis (= M. schreibersi)*, Pretoria, and we have taken two larvae off *Eptesicus capensis* at Onderstepoort. It has frequently been known to attack human beings living in houses frequented by bats, and we have received a specimen taken off a cat at Vryburg, C.P. In Tunis it has been demonstrated to transmit a spirillum, *Treponema vespertilionis*, to bats.

Family IXODIDAE.

Key to the Genera.

1. Integument of body leathery, having a definite pattern and resembling that of Argasidae; scutum resembling the rest of body-integument, especially parts thereof; palpi short, the joints flexible, the third and fourth cylindrical, the latter being terminal; eyes absent; anal groove curving in front of anus ... ... *Nuttalliella*, p. 284.

   Integument of body without a definite pattern; scutum not resembling rest of body-integument; palpi long or short, joints not flexible, the fourth situated ventrally at the distal end of the third segment 2

2. Anal grooves surrounding the anus in front 3
   Anal grooves surrounding the anus behind (in *Boophilus* and *Margaropus* the anal groove is faint or obsolete) 4

3. Inornate, eyes and festoons absent; males with a pregenital, median, anal, two adanal and two epimeral plates on the venter ... ... *Ixodes*, p. 284.

4. Hypostome and palpi short 5
   Hypostome and palpi long 10

5. Eyes absent ... ... *Haemaphysalis*, p. 288.
   Eyes present 6

6. Festoons present 7
   Festoons absent 9

7. Males with coxae iv much larger than coxae i to iii, no plates or shields on ventral surface of male 8

   Males with coxae iv not larger than coxae i to iii, a pair of adanal shields and usually a pair of accessory adanal shields on ventral surface of male. Species usually inornate, basis capituli generally hexagonal dorsally *Rhipicephalus*, p. 291.

8. Species ornate, basis capituli rectangular dorsally *Dermacentor*, p. 290.

   Species inornate, basis capituli hexagonal dorsally with prominent lateral angles. Coxae iv of male with two long spines ... ... *Rhipicentor*, p. 291.

9. Inornate; coxae i with a small spine. Male with median plate projecting backwards on either side of the anus, and with a caudal protrusion when engorged. Fourth pair of legs of male dilated ... ... *Margaropus*, p. 299.

   Inornate; coxae i bifid. Male with a pair of adanal and accessory shields, and a caudal protrusion. Fourth pair of legs normal ... ... *Boophilus*, p. 300.

10. Eyes present 11

    Eyes absent or rudimentary 12

11. Festoons absent or present. Males with a pair of adanal shields and two posterior abdominal protrusions, accessory adanal shields absent or present ... *Hyalomma*, p. 301.

    Species usually ornate; festoons present. Male without adanal shields, but small plaques may be present on the venter near the festoons ... ... *Amblyomma*, p. 303.

12. Species occurring almost exclusively on Reptilia *Aponomma*, p. 307.

Genus Nuttalliella Bedford.

Nuttalliella Bedford, *Parasit.*, XXIII, ii, p. 231 (1931).

This genus comprises a single species.

1. **Nuttalliella namaqua** Bedford.

Nuttalliella namaqua Bedford, *Parasit.*, XXIII, ii, p. 231, Pl. 10 and fig. 1 (1931).

Described from a single fully engorged female collected under a stone at Kamieskroon, Little Namaqualand, by Dr. R. F. Lawrence.

Genus Ixodes Latreille.

Ixodes Latreille, *Précis des caractères génériques des insects, disposés dans un ordre naturel*, p. 179 (1795).

Ixodes Nuttall & Warburton, Ticks: Mon. Ixod., ii, p. 116, f. 115-119 (1911).

This genus is widely distributed and comprises a number of species, seven of which have been found in South Africa.

Genotype: *Acarus ricinus* Linné.

Key to the South African Species.

Adults.

1. Anal grooves sub-parallel or divergent 2

   Anal grooves horseshoe-shaped or closed or nearly so behind 3

2. Anal grooves sub-parallel ... ... *I. rubicundus*.

   Anal grooves slightly divergent; legs longer and more slender; ♂ unknown ... ... *I. simplex*.

3. Anal grooves horseshoe-shaped 4
   Anal grooves closed or almost closed behind 6
4. Coxa i to iv of ♀ with sharp external spur, coxi i also with sharp internal spur; ♂ unknown ... ... *I. daveyi.*
   Coxae i to iv of ♀ without such spurs 5
5. Scutum of ♀ much longer than broad (1·26 × 0·8 mm.); ♂ unknown ... ... *I. nairobiensis.*
   Scutum of ♀ only very slightly longer than broad *I. pilosus.*
6. Anal grooves circular; tarsi iv of ♂ humped some distance from apex ... ... *I. rasus.*
   Anal grooves ending in a point behind; tarsi iv of ♂ tapering ... ... *I. ugandanus.*

1. **Ixodes daveyi** Nuttall.

I. daveyi Nuttall, *Parasit.*, VI, ii, p. 133, f. 2 (1913).

A single ♀ recorded by Bedford and Hewitt (1925) taken off a pink-billed weaver (*Quelea sanguinirostris lathami*) at Onderstepoort, Transvaal. This species was described from a single ♀ also taken off a bird, a plantain-eater (*Gallirex johnstoni*), on the northern ridge of Ruwvenzori, Uganda. Bequaert (*Rev. de Zool. et Botan.* Afr., XX, iii, p. 214, 1931) records a ♀ from a warbler, *Cisticola natalensis kapistra* in the Belgian Congo.

2. **Ixodes pilosus** Koch, "Sheep paralysis tick" (Fig. 8).

I. pilosus Koch, *Arch. f. Naturg.*, X, i. p. 233 (1844).

I. pilosus var. howardi Neu. *Trans. Roy. Soc. S. Afr.*, I, p. 125 (1908).

I. pilosus (Koch) Howard, *Ann. Trl. Mus.*, I, ii, p. 94 (1908).

I. pilosus var. howardi (Neu) Howard, *ibid.*, p. 95, Pl. 4, figs. a-k (1908).

I. pilosus (Koch) Nutt. & Warb., Ticks: Mon. Ixod., ii, p. 221, f. 217-221 (1911).

I. pilosus var. howardi (Neu.) Nutt. & Warb., *ibid.*, ii, p. 226 (1911).

This tick has been found in various localities in the Cape Province, Transvaal, Orange Free State, Natal and Zululand. It is probably only common in grass districts near the coast. Lounsbury (1900) records it from cattle, horses, goats and pigs. Mally (1904) on sheep. Howard (1908) from man, cat, dog, leopard, bushbuck, hedgehog (*Atelerix frontalis*) and bat (*Rhinolophus geoffroyii augur*)*, Dönitz (1910) from a civet cat at Umtali, and Nuttall and Warburton from a duiker. Females have been taken off *Tragelaphus sylvaticus* (bushbuck), Black Umfolosi, Zululand (coll. J. Dickson); a ♀ off *Felis ocreata caffra* (Cape wild cat), Worcester, C.P. (coll. P. L. le Roux); a ♀ off *Atelerix frontalis*, Pretoria District (coll. G.A.H.B.),

* Specimen from bat probably *I. simplex* Neu.

and a female off *Nototragus melanotis* (grysbok), Bredasdorp, C.P. (coll. R. F. Lawrence). Specimens recorded from one or two hosts in first edition prove to be *I. rubicundus.* Recorded by Nuttall (1916) from hartebeest and grysbok, N. Rhodesia; *Felis capensis hindei* Wr., Kenya Colony; dogs, reedbuck, oribi and roan antelope, Nyasaland, and from Tanganyika Territory. Bequaert (Rep. Harv.-Afr. Exped. Liberia and Belg. Congo, p. 799, 1931) recorded it from a duiker, *Cephalophus melanorheus schüsteri*, Tanganyika Territory.

This species is capable of producing paralysis in sheep, goats and cattle.

3. **Ixodes nairobiensis** Nuttall.

I. nairobiensis Nuttall, *Parasit.*, VIII, iii, p. 299, f. 4 (1916).

I. elongatus, Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 493, Pl. 1, f. 1, 2 (1929).

Described by Nuttall from a ♀ found on a dog at Nairobi, Kenya Colony, and by Bedford from a ♀ found on *Mastomys coucha* (multimammate mouse), Onderstepoort. We have also received a ♀ from Mr. L. Hill taken off a warthog, Lake Naivasha, Kenya Colony.

4. **Ixodes rasus** Neumann.

I. rasus, Neumann, *Mem. Soc. Zool. France*, XII, p. 137, f. 12-14 (1899).

I. (I.) rasus Neumann, *Ixod., Das Tierreich.*, p. 26 (1911).

I. rasus (Neu.) Nutt. & Warb., Ticks: Mon. Ixod., ii, p. 228, f. 224-226 (1911).

A ♀ and nymphs taken off *Procavia* sp. (rock rabbit), Mtabamhlope, Natal; also a ♀ off *Herpestes caffer* (large grey mongoose), Pietermaritzburg, Natal (coll. L. Hill), and a ♀ off *Myonax cauui* (slender mongoose), Tzaneen, Transvaal (coll. B. De Meillon). Specimens have also been taken off impala, *Aepyceros melampus* (coll. R. A. Cooley). Neumann (1899) described a ♂ and ♀ from *Hyrax sp.*, Congo, and in 1911 recorded it from *Herpestes ichneumon*, *Cephalophus leucogaster* and dog, and gave the following localities: Cameroons, Togo and Tanganyika Territory. Nuttall and Warburton (1911) recorded it from cattle, Uganda, and from leopard, man and dog in Ashanti. Nuttall (1916) recorded it from man, Abyssinia; *Felis capensis hindei* Wr., Kenya Colony; wild pigs and *Manis* sp., Cameroon; goat, Belgian Congo; leopard, S. Rhodesia; dog, Gold Coast, and from Spanish Guinea. It has also been recorded from the Belgian Congo by Bequaert (1931) on *Dendrohyrax adolfi-friederici* Brauer, by Schouteden (1927) on *Okapia johnstoni* Sclater, and by Schwetz (1927) on *Aulacodus swinderianus* Temm.

5. **Ixodes rubicundus** Neumann.

I. rubicundus Neumann, *Arch. Parasit.*, VIII, p. 460, f. 2 (1904).

I. rubicundus (Neu.) Howard, *Ann. Tvl. Mus.*, 1, ii, p. 97, Pl. 4, figs. 1 (a, b) (1908).

I. rubicundus (Neu.) Nutt. & Warb., Ticks: Mon. Ixod., ii, p. 204, f. 197, 198 (1911).

Described from specimens found on sheep in the eastern Cape Province. It is common in the Middelburg District, C.P., where I have found adults on horses, cattle, sheep, goats, dogs and vaal rhebok *(Pelea capreolus)*, and the immature stages on Cape red hare *(Pronolagus crassicaudatus)* and elephant shrew. Adults have also been found on sheep and cattle near Johannesburg and on *Damaliscus dorcas* (bontebok), *Raphiceros campestris* (steenbok) and *Nototragus melanotis* (grysbok), Bredasdorp, C.P. (coll. R. F. Lawrence). Nuttall (1916) has recorded it from dogs, Broken Hill, N. Rhodesia. It is capable of producing paralysis in sheep, goats, cattle and vaal rhebok.

6. **Ixodes simplex** Neumann.

♀, ○. *I. simplex* Neumann, *Arch. de Parasit.*, X, p. 197 (1906).

♀. *I. simplex* (Neu.) Nutt. & Warb., Ticks: Mon. Ixod., ii, p. 207, f. 199 (1911).

One female, two nymphs and a larva taken off a bat, *Myotis tricolor*, in a cave at Irene, near Pretoria, 25th October, 1931 (coll. G. A. H. B.). The specimen recorded by Howard (1908) as *I. pilosus howardi* from *Rhinolophus geoffroyii augur* was probably this species. It was described from one female and one nymph taken off *Rhinolophus ferrum-equinum* (Schreb.), Shanghai, and one female from *Vespertilio sp.*, Gaboon, French Congo.

7. **Ixodes ugandanus** Neumann.

I. ugandanus Neumann, *Arch. Parasit.*, X, p. 198 (1906).

I. ugandanus Neumann, *Ixod., Das. Tierreich*, p. 25 (1911).

I. ugandanus (Neu.) Nutt. & Warb., Ticks: Mon. Ixod., ii, p. 230, f. 227, 228 (1911).

Specimens have been taken off *Thryonomys swinderianus variegatus* (Natal cane-rat), Umfolosi Reserve, Zululand (coll. P. L. le Roux); also off same host in Zululand (coll. H. H. Curson). It was described by Neumann from a ♂ and ♀ taken off a cane-rat in Uganda, and he also recorded it from Tanganyika Territory. Nuttall and Warburton (1911) record specimens from a large rodent and sheep in West Africa.

Genus Haemaphysalis Koch.

Haemaphysalis Koch, *Arch. f. Naturg.*, X, i, p. 237 (1844).

Haemaphysalis Nuttall & Warburton, Ticks: Mon. Ixod., ii, p. 119, f. 120 (1911).

This genus is very widely distributed and contains a number of species, the majority having been found in Asia.

Genotype: *Haemaphysalis concinna Koch* (Designated by Neumann, 1901).

Key to the South African Species.

MALES.

1. Coxal spurs normal 2
   Coxa iv with a long needle-like spur ... ... *H. aciculifer.*
2. Palpal article iii without a spur on dorsum 3
   Palpal article iii with a spur on dorsum; lateral grooves very short ... ... *H. parmata.*
3. Scutum short-oval 4
   Scutum elongate, much longer than broad 5
4. Palpal article ii strongly salient laterally ... ... *H. hoodi.*
   Palpal article ii not salient laterally ... ... *H. silacea.*
5. Palpal article iii with a ventral retrograde spur ... *H. leachii.*
   Palpal article iii without a spur on venter ... ... *H. cooleyi.*

Females.

1. Palpal article iii without a spur on dorsum 2
   Palpal article iii with a spur on dorsum; scutum about as broad as long ... ... *H. parmata.*
2. Scutum about as broad as long 3
   Scutum much longer than broad 5
3. Palpal article iii with a ventral retrograde spur 4
   Palpal article iii with a spur on venter ... ... *H. hoodi.*
4. Palpal article iii slightly salient laterally ... *H. aciculifer.*
   Palpal article iii not salient laterally ... ... *H. silacea.*
5. Palpal article iii with a ventral retrograde spur ... *H. leachii.*
   Palpal article iii without a spur on venter ... ... *H. cooleyi.*

1. **Haemaphysalis aciculifer** Warburton.

H. aciculifer Warburton, *Parasit.*, VII, p. 125 (1913).

H. aciculifer (Warb.) Nutt. & Warb., Ticks: Mon. Ixod., iii, p. 411, f. 345, 346 (1915).

One ♂ taken off *Redunca arundinum* (reedbuck) in northern Zululand, 29th October, 1924 (coll. G. A. H. B.).

This species was described from a ♂ and ♀ found on the antelope, *Cobus thomasi*, in Uganda. Nuttall and Warburton (1915) also received a ♀ taken off a reedbuck in the Gold Coast.

2. **Haemaphysalis cooleyi** Bedford.

H. cooleyi Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 494, Pl. 2, f. 3 A-D (1929).

Described from adults and nymphs taken off *Procavia coombsi* (Transvaal dassie) near Onderstepoort; also from nymphs taken off *Pedetes caffer* (springhare) at Pienaars River, Transvaal.

3. **Haemaphysalis hoodi** Warburton and Nuttall.

♂, ♀. *H. hoodi* Warb. & Nutt., *Parasit.*, II, i, p. 62, f. 7, 8 (1909).

♂, ♀, ○, L. *H. africana* Howard, *Ann. Trl. Mus.*, pp. 219-223, Pl. 34 (1909).

♂, ♀, ○, L. *H. hoodi* (Warb. & Nutt.) Nutt. & Warb., Ticks: Mon. Ixod., iii, p. 483, f. 423-426 (1915).

Two females and two males recorded by Bedford and Hewitt (1925) taken off a redwing starling (*Amydrus morio*) at Pietermaritzburg, Natal.

This species was described from numerous females, males and one nymph taken off fowls at Bathurst, Gambia. Nuttall and Warburton (1915) also recorded it from a plantain-eater, *Gymnoschizorhis leopardi* Shelley, Kenya Colony; the ears of partridges in Nyasaland; guinea-fowl (*Numida meleagris* Linné), Gold Coast, and a Senegal coucal (*Centropus senegalensis*), Sierra Leone. Howard (1909) recorded it from a Burchell's coucal (*Centropus burchelli*), Portuguese East Africa.

4. **Haemaphysalis leachii** (Audouin), " The dog tick ".

Ixodes leachii Audouin in Savigny, *Desc de l'Egypte*, Pl. 9, f. 9 (1826).

Haemaphysalis leachi (Aud.) Howard, *Ann. Trl. Mus.*, I, ii, p. 160, Pl. 16, figs. a-m (1908).

Haemaphysalis leachi (Aud.) Nutt. & Warb., Ticks: Mon. Ixod., iii, p. 460, Pl. 12, 13 and figs. 398-410 (1915).

This species is common and widely distributed in Africa, and also occurs in Asia and Australia. Howard (1908) records it from the following hosts in South Africa: Dog, cat, cattle (rare), jackal; lion; leopard; black-footed cat, *Micropelis felis* (= *Felis nigripes*); civit cat (*Civettictis civetta*); hedgehog (*Atelerix frontalis*), and nymphs on striped mouse, *Rhabdomys pumilio* (= *Arvicanthis pumilio*) and a tortoise. Nuttall and

Warburton (1915) recorded it from *Suricata suricatta* (= *S. tetradactyla*) Deelfontein, C.P., and Ingram (1927) from *Tatera lobengulae* (gerbille). We have found it on *Rattus rattus* (black rat), *Otomys irroratus* (African water rat) and *Mastomys coucha* (multimammate mouse) at Onderstepoort. Adults have been taken off *Atelerix frontalis* at Petrusburg, O.F.S., and in the Pretoria District; *Protelis cristatus* (aardwolf), Umkomaas Valley, Natal; *Vulpes chama* (silver fox), Petrusburg, O.F.S.; *Genetta tigrina* in the Albany District, C.P.; *Calogale cauui* (slender mongoose), and *Genetta felina*, Rustenburg District, Transvaal; *Cynictis penicillata* (yellow mongoose), Pretoria District; *Mellivora capensis* (Cape badger), Gibson District, S.W.A. (coll. Dr. Schmidt); *Lepus capensis* (Cape hare), *Ictonyx striatus* (stink muishond) and *Geosciurus capensis* (ground squirrel), Glen, O.F.S. (coll. R. Bigalke); *Pronolagus crassicaudatus rupestris* (Cape red hare) in the Middelburg District, C.P. Nymphs have been collected off *Rattus rattus frugivorus* (arboreal black rat) at Bothaville, O.F.S., and off *Pedetes caffer* (springhare) at Petrusburg.

This tick is the principal transmitting agent of canine piroplasmosis or biliary fever to dogs in South Africa.

5. **Haemaphysalis parmata** Neumann.

♂, ♀. *H. parmata* Neu., *Arch. Parasit.*, IX, p. 228 (1905).

♂, ♀, ○, L. *H. parmata* (Neu.) Nutt. & Warb., Ticks: Mon. Ixod., iii, p. 418, f. 350-353 (1915).

Specimens have been taken off *Tragelaphus sylvaticus* (bushbuck) in Zululand (coll. H. H. Curson). Nuttall and Warburton (1915) recorded it from the following hosts: Cattle and bushbuck in Uganda; Jackson's hartebeest in Kenya Colony; antelope and buffalo in the Belgian Congo; cattle and harnessed antelope in Sierra Leone, and cattle, goat, sheep and pig in the Cameroon.

6. **Haemaphysalis silacea** Robinson.

♀. *H. silacea* Robinson, *Parasit.*, IV, iv, p. 478 (1911).

♀. *H. silacea* (Robins.) Nutt. & Warb., Ticks: Mon. Ixod., iii, p. 416, f. 439 (1915).

♀, ♂. *H. silacea* (Robins.) Bedf. & Hew., *S. Afr. Journ. Nat. Hist.*, V, i, p. 260, Pl. 19, f. 4-6 (1925).

Described by Robinson from females collected on an ox at Gunubie Park, East London, Cape Province. Bedford and Hewitt (1925) recorded males and females taken off an ox at Riebeek East, Cape Province.

Genus Dermacentor Koch.

Dermacentor Koch, *Arch. f. Naturg.*, X, i, p. 235 (1844).

Dermacentor Nuttall & Warburton, Ticks: Mon. Ixod., ii, p. 120, f. 121 (1911).

This genus contains a number of species, the majority being found in America. Only two species have been recorded from Africa.

1. **Dermacentor rhinocerotis** (De Geer). "The rhinoceros tick".

Acarus rhinocerotis De Geer, *Mém. Hist. Ins.*, VII, p. 160, Pl. 38, f. 5, 6 (1778).

D. rhinocerotis (De Geer) Howard, *Ann. Trl. Mus.*, I, ii, p. 157, Pl. 16, figs. o, p. (1908).

D. rhinocerotis (De Geer) Neu., *Ixod., Das Tierreich*, p. 102 (1911).

This species has been recorded taken off rhinoceros at Durban, Natal, in the Cape Province, Mozambique, Zambesi and Zanzibar. In the Onderstepoort collection there are two males taken off a black rhinoceros *(Diceros bicornis)* in the Hluhluwe Game Reserve, Zululand, by D. T. Mitchell, and two males collected by Captain Taylor from the same host in Rhodesia.

Genus Rhipicentor Nuttall and Warburton.

Rhipicentor Nutt. & Warb., *Proc. Phil. Soc. Cambridge*, XIV, p. 398 (1908).

Rhipicentor Nutt. & Warb., *Ticks: Mon. Ixod.*, ii, p. 121, f. 123, 124 (1911).

This genus includes two species.

Genotype: *Rhipicentor bicornis* Nuttall and Warburton.

1. **Rhipicentor nuttalli** Cooper and Robinson.

Rhipicentor nuttalli Cooper & Robins., *Proc. Cambr. Phil. Soc.*, XIV, p. 462, fig. (Feb., 1908).

Rhipicentor vicinus Neumann, in Howard, *Ann. Trl. Mus.*, I, ii, p. 155, Pl. 7, figs. f-i (Aug., 1908).

Rhipicentor vicinus Neumann, *ibid.*, I, ii, p. 170 (Aug., 1908).

Described by Neumann from specimens taken off hedgehog, *Atelerix frontalis (= Erinaceus frontalis)* at Pienaar's River and Pretoria. We have taken specimens off the same host at Onderstepoort, and two females off dogs in the same locality. A female has been taken off a koodoo *(Strepsiceros strepsiceros)* at Omarura, South-West Africa.

Genus Rhipicephalus Koch.

Rhipicephalus Koch, *Arch. Naturg.*, X, p. 238 (1844).

Rhipicephalus (Koch) Nutt. & Warb., Ticks: Mon. Ixod., ii, p. 122 (1911).

This genus contains a number of species, the majority occurring in Africa. Some of them are very important on account of the rôle they play in the transmission of diseases to domestic animals. The majority of the species are difficult to identify, especially the females, owing to structural features being few, and the great range of individual variation, both in size and structure.

Key to the South African Species.

MALES.

1. Eyes hemispherical, orbited 2
   Eyes flat 4
2. Legs brown; coxae i projecting in front, prominent when viewed dorsally; punctations on scutum numerous, but not coalescing ... ... *R. oculatus.*
   Legs not brown; coxae i not prominent when viewed dorsally; punctations on scutum coalescing, making the scutum appear shagreened 3
3. Legs yellowish-red in colour, not banded ... ... *R. evertsi.*
   Legs yellowish-red in colour with pale bands *R. evertsi mimeticus.*
4. Lateral grooves absent; basis capituli with lateral margins rounded 5
   Lateral grooves present; basis capituli usually with prominent lateral angles 6
5. Scutum brown with one to nine pale spots, and a few large scattered punctations ... ... *R. maculatus.*
   Scutum without pale spots, the punctations numerous, large and equal; coxae i prominent when viewed dorsally *R. sp.*
6. Adanal shields with posterior margins straight or convex, not strongly pointed posteriorly 7
   Adanal shields with posterior margins either concave or with a median prolongation 13
7. Basis capituli with prominent lateral angles; coxae i not prominent when viewed dorsally 8
   Basis capituli with lateral margins rounded; coxae i prominent when viewed dorsally; scutum with fine and a few large punctations, mainly distributed in the middle; on the inside of the lateral grooves there is an area free of punctations. Fully fed ♂♂ with a long caudal process ... ... *R. appendiculatus.*
8. Scutum sub-triangular, with a number of fine punctations and a few large scattered ones ... ... *R. deltoideus.*
   Scutum oval 9
9. Scutum shiny, with a few large punctations 10
   Punctations on scutum more numerous, spread over the surface 11
10. Punctations on scutum unequal, those on the posterior half being particularly large and deep ... ... *R. punctatus.*
    Large punctations on scutum equal, more or less arranged in longitudinal lines, a number of very fine indistinct punctations may also be present ... ... *R. simus.*
11. Scutum with punctations unequal, scattered over the surface, with three posterior grooves; adanal plates triangular or subtriangular ... ... *R. sanguineus.*
    Punctations on scutum very numerous 12

12. Scutum with large, subequal punctations 13
   Scutum with numerous fine punctations and a few large ones ... ... *R. follis.*

13. Scutum with a distinct pseudo-scutum similar to that of the female, punctations not contiguous and less numerous on the lateral margins ... ... *R. sulcatus.*
   Scutum without a pseudo-scutum, punctations more or less contiguous and numerous on lateral margins *R. capensis.*

14. Adanal shields with the posterior margins produced into a point in the middle ... ... *R. theileri.*
   Adanal shields with the posterior margins concave 15

15. Adanal shields bifid, the postero-external angles longer than the postero-internal angles 16
   Adanal shields with the postero-external angles short and rounded, the internal angles very long and pointed; coxae i prominent when viewed dorsally ... *R. duttoni.*

16. Scutum with a few scattered large punctations and numerous fine ones ... ... *R. tricuspis.*
   Scutum with large punctations arranged more or less in longitudinal lines, fine punctations hardly visible *R. lunulatus.*

FEMALES.

1. Female unknown ... ... *R. follis.*
   Females known 2

2. Eyes hemispherical, orbited; scutum with numerous closely set punctations 3
   Eyes flat, not orbited 5

3. Legs yellowish-red 4
   Legs brown ... ... *R. oculatus.*

4. Legs not banded ... ... *R. evertsi.*
   Legs with pale bands ... ... *R. evertsi mimeticus.*

5. Scutum brown with a largish yellowish-white area posteriorly, and with a few largish punctations; dorsum of abdomen with patches of white clavate scales *R. maculatus.*
   Scutum brown, without pale markings 6

6. Scutum without lateral grooves, shiny, with a few large scattered punctations in front, less numerous behind *R. punctatus.*
   Scutum with lateral grooves, usually well developed, and with more numerous punctations 7

7. Lateral grooves not extending to anterior margin of scutum; punctations unequal, not very numerous ... *R. theileri.*
   Lateral grooves extending to anterior margin of scutum ... 8

8. Scutum longer than wide 9
   Scutum about as wide as long 12

9. Punctations on scutum unequal 10
   Punctations on scutum equal or subequal 11
10. Basis capitulum half the width of scutum ... *R. sanguineus.*
    Basis capitulum three-quarters the width of scutum, with very long and pointed lateral angles ... ... *R. deltoideus.*
11. Punctations on scutum equal, largish and numerous on median area and very scarce on lateral margins; lateral grooves shallow, without punctations ... ... *R. sp.*
    Punctations on scutum subequal, deep, contiguous in the deep lateral grooves, small and less numerous on lateral margins, except round the eyes where they are closely set ... ... *R. sulcatus.*
12. Punctations on scutum large, contiguous ... ... *R. capensis.*
    Punctations on scutum separated 13
13. Fine punctations on scutum very apparent *R. appendiculatus.*
    Fine punctations on scutum scarcely visible 14
14. Punctations on scutum uniformly distributed over the surface; joints of legs slightly dilated ... ... *R. duttoni.*
    Punctations less numerous on lateral margins; joints of legs normal 15
15. Scutum with lateral margins convex behind the eyes *R. simus.*
    Scutum with lateral margins concave behind the eyes *R. tricuspis.*

In addition to the above species Howard (p. 130, 1908) has recorded *R. bursa* Canestrini and Fanzago from South Africa, but judging from his descriptions and figures the specimens were most probably *R. capensis.* *R. bursa*, which is closely allied to *R. follis* Dönitz, occurs in southern Europe and North Africa.

1. **Rhipicephalus appendiculatus** Neumann, "The brown tick" (Figs. 9-11).

♂, ♀. *R. appendiculatus* Neu., *Mém. Soc. Zool. France*, XIV, p. 270 (1901).

♂, ♀. *R. nitens* Neu., *Arch. de Parasit.*, VIII, p. 462 (1904).

R. appendiculatus (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 128, Pl. 8, fig. d; Pl. 9, fig. d; Pl. 10, fig. d; Pl. 11, figs. b, d, g, i, k (1908).

R. nitens (Neu.) Howard, *ibid.*, I, ii, p. 131 (1908).

R. appendiculatus (Neu.) Nuttall, *Bul. Ent. Res.*, VI, iv, p. 323, 344, f. 18-21 (1916).

This tick is common in parts of the Union, and has also been recorded from Rhodesia, Portuguese East Africa and the Belgian Congo. It has been found on cattle, horses, mules, sheep, goats, *Nyala angasi* (nyala) and *Tragelaphus sylvaticus* (bushbuck) in the Mkusi Reserve, Zululand (coll. D. T. Mitchell and H. H. Curson); *Aepyceros melampus* (impala), Kruger

National Park, Transvaal (coll. A. D. Thomas); *Strepsiceros strepsiceros* (Cape Koodoo), 30 miles north of Messina, Transvaal (coll. R. A. Cooley); *Kobus ellipsiprymnus* (waterbuck), Northern Transvaal; *Paraxerus cepapi* (yellow-footed squirrel), Klasserie, Transvaal, *Lepus zuluensis* (Zululand hare), Pretoria District (coll. R. A. Cooley), and *L. capensis* (Cape hare). Howard (1908) has also recorded it from dog, *Lycaon pictus* (Cape hunting dog), *Syncerus caffer* (Cape buffalo) and man. It is the chief transmitting agent of East Coast fever to cattle, and also conveys redwater and *Piroplasma mutans* to cattle.

2. **Rhipicephalus capensis** Koch, "The Cape brown tick".

♂. *R. capensis* Koch, *Arch. f. Naturg.*, X, p. 238 (1844).

♂, ♀. *R. capensis* (Koch) Howard, *Ann. Tvl. Mus.*, I, ii, p. 123, Pl. 8, fig. c; Pl. 9, fig. c; Pl. 10, fig. b (1908).

This species is not common in South Africa. Adults have been taken on grass at Onderstepoort (coll. G. A. H. B.); also off cattle at Sycamore, Transvaal (coll. G. A. H. B.) and *Lepus saxatilis* (great hare), Glen, O.F.S. (coll. R. Bigalke). Howard (1908) recorded it from cattle, goat, horse, dog and *Varanus saurus* and gave the following localities: Namaqualand, Cape Province and Transvaal. It is a transmitting agent of East Coast fever to cattle.

3. **Rhipicephalus deltoideus** Neumann.

R. deltoideus Neu., *Tijdschr. v. Ent.*, LIII, p. 13, Pl. 1, f. 3-7 (1910).

Described from males and females taken off unknown host in Basutoland. Bequaert (Rep. Harv.-Afr. Exped. Liberia and Belg. Congo, ii, p. 807, 1930), records taking specimens off a hare in the Belgian Congo.

4. **Rhipicephalus duttoni** Neumann, "Dutton's brown tick".

♂. *R. duttoni* Neu., *Ann. Trop. Med. & Parasit.*, I, i, p. 115, f. 22, 23 (1907).

♂. *R. duttoni* (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 127 (1908).

Originally described from a male taken off a bovine in the Belgian Congo. Howard (1908) recorded a few specimens found in the Northern Transvaal; also from Mozambique.

5. **Rhipicephalus evertsi** Neumann, "The red tick".

♂, ♀. *R. evertsi* Neu., *Mem. Soc. Zool. France*, X, p. 405, f. 36 (1897).

♂, ♀, ○, L. *R. evertsi* (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 119, Pl. 8, figs. a, i, k; Pl. 9, fig. a; Pl. 10, fig. a; Pl. 11, figs. a, e (1908).

This species, which is a two-host tick, is very common in the Union, and has also been recorded from South-west Africa, Mozambique, Rhodesia, Tanganyika Territory and the Belgian Congo. Both adults and immature forms have been found on horses, donkeys, mules, cattle, sheep and goats. Adults have also been found on dogs; *Hippotigris burchelli wahlbergi* (Wahlberg's zebra), Umfolosi Reserve, Zululand (coll. G. A. H. B.); *Gorgon taurinus* (blue wildebeest), Umfolosi, Zululand (coll. C. C. Kent); *Ozanna nigra* (sable antelope), Acorn Hoek, Transvaal (coll. R. A. Cooley); *Damaliscus albifrons* (blesbok), Pretoria District (coll. H. O. Mönnig); *Equinus equinus* (roan antelope), *Strepsiceros strepsiceros* (Cape koodoo), *Aepyceros melampus* (impala) and *Raphiceros campestris* (steenbuck), about 30 miles north of Messina, Transvaal (coll. R. A. Cooley); *Sylviacapra grimmi* (Cape duiker), Acorn Hoek, Transvaal (coll. R. A. Cooley); *Antidorcas marsupialis* (springbok), Onderstepoort (coll. G. A. H. B.); *Tragelaphus sylvaticus* (bushbuck), *Kobus ellipsiprymnus* (waterbuck), northern Transvaal; *Syncerus caffer* (buffalo), Umfolosi Reserve, Zululand, and *Thryonomys swinderianus variegatus* (Natal cane rat), Nylstroom, Transvaal. Nymphs on *Damaliscus dorcas* (bontebok), *Raphiceros campestris* (steenbok) and *Nototragus melanotis* (grysbok), Bredasdorp, C.P. (coll. R. F. Lawrence). Howard (1908) also recorded specimens from giraffe, eland and reedbuck. Nymphs have been taken off *Papio griseipes* (chacma baboon), Grahamstown, C.P. (coll. R. Paine); *Lepus zuluensis* (Zululand hare), Hartebeestpoort, near Pretoria (coll. G. A. H. B.) and *Lepus capensis* (Cape hare), Fort Beaufort, C.P. (coll. C. P. Lounsbury).

This tick has been proved to transmit East Coast fever and redwater to cattle, spirillosis to cattle, horses and sheep, and biliary fever to horses, mules and donkeys.

5A. **Rhipicephalus evertsi mimeticus** Dönitz.

R. evertsi var. mimetica Dönitz, Die Zecken Südafri., p. 475 (1910).

R. evertsi var. albigeniculatus Warburton in Nuttall, *Bull. Ent. Res.*, VI, iv, p. 327 (1916).

Recorded by Bedford and Hewitt (1925) taken off horses, cattle and a koodoo *(Strepsiceros strepsiceros)* at Omaruru, South-west Africa (coll. Dr. Schmidt). Males have also been taken off eland *(Taurotragus oryx)* from South-West Africa in the Zoological Gardens, Johannesburg (coll. G. Martinaglia). This variety was described by Dönitz from specimens collected in South-west Africa, and Nuttall (1916) recorded it from cattle in the Lower Congo.

6. **Rhipicephalus follis** Dönitz.

R. follis Dönitz, Die Zecken Südafr., p. 481, Pl. 14B, f. 12; Pl. 16A, f. 3 (1910).

Described from a male collected in South Africa. Host unknown.

7. **Rhipicephalus lunulatus** Neumann.

♂. *R. lunulatus* Neu., *Arch. de Parasit.*, XI, p. 215, f. 1 (1907).

♂, ♀. *R. lunulatus* (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 126, Pl. 8, fig. g; Pl. 9, fig. g; Pl. 10, fig. g (1908).

Recorded by Howard (1908) taken off dogs and hedgehog, *Atelerix frontalis (= Erinaceus frontalis)* in the Zoutpansberg District, Transvaal. It was originally described from specimens taken off a horse in the Belgian Congo.

8. **Rhipicephalus maculatus** Neumann.

♂, ♀. *R. maculatus* Neu., *Mém. Soc. Zool. France*, XIV, p. 273 (1901).

♂. *R. ecinctus* Neu., *ibid.*, XIV, p. 275 (1901).

♂, ♀. *R. maculatus* (Neu.) Warburton, *Parasit.*, V, i, pp. 15-19, f. 10, 11 (1912).

Recorded by Bedford and Hewitt (1925) taken off a buffalo *(Syncerus caffer)* and a white rhinoceros *(Ceratotherium simum)* in the Umfolosi Game Reserve, Zululand; also from a black rhinoceros *(Diceros bicornis)* and a koodoo *(Strepsiceros strepsiceros)* in the Hluhuwe Game Reserve, Zululand, and from a black rhinoceros at Mduna River, Zululand. The writer has taken adult specimens on himself in the Umfolosi Game Reserve, and specimens have been taken in the same reserve off zebra *(Hippotigris burchelli wahlbergi)* and a duiker *(Sylvia capra grimmi)* by C. C. Kent and P. L. le Roux; also at Hlabesa, Zululand, off Natal warthog (*Phacochoerus sundivalli*) by D. T. Mitchell. The type was recorded from a beetle, *Platymeris horrida* collected in the Cameroons, and specimens have also been taken on grass and on a buffalo in Kenya Colony.

9. **Rhipicephalus oculatus** Neumann, " The eyed tick ".

R. oculatus Neu., *Mém. Soc. Zool. France*, XIV, p. 274 (1901).

R. oculatus (Neu.) Howard, *Ann. Tvl. Mus.*, *I*, ii, p. 122, Pl. 8, fig. b; Pl. 9, fig. b; Pl. 10, fig. c (1908).

This species is a common parasite on hares. Adults have been taken off *Lepus zuluensis* (Zululand hare) in various localities in the Transvaal (coll. R. A. Cooley); off *Lepus capensis* (Cape hare), Middelburg, C.P. (coll. C. P. Lounsbury), *L. capensis ochropus* at Bloemfontein and Glen, O.F.S. (coll. R. A. Cooley); *L. saxatalis* (great hare), Kleinpoort, Albany District, C.P. (sent by J. Hewitt); *Aepyceros melampus* (impala), Transvaal (coll. R. A. Cooley); *Strepsiceros strepsiceros* (Koodoo), Omaruru, South-West Africa (coll. G. Schmidt); *Taurotragus oryx* (eland), from South-West Africa, in the Zoological Gardens, Johannesburg (coll. G. Martinaglia); sheep at Ficksburg, C.P.; goat and horse at Pretoria, and off cattle in various localities. Howard (1908) also recorded it from cattle,

but it is rare on these animals. Neumann (1911) recorded it from cattle, *Giraffa schillingsi* and *Gazella granti*, and gave the following localities: Damaraland, Kenya Colony and Tanganyika Territory.

10. **Rhipicephalus punctatus** Bedford.

♂, ♀, ○. *R. punctatus* Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 495, Pl. 3, f. 4B, D, 5B (1929).

Described from specimens taken off *Procavia coombsi* (Transvaal dassie), Onderstepoort, and dassie, Omaruru, South-West Africa (coll. G. Schmidt). Adults have also been taken off sheep, Victoria West, C.P.

11. **Rhipicephalus sanguineus** (Latreille).

Ixodes sanguineus Latr., Gen. Crust. et Ins., I, p. 157 (1806).

R. sanguineus (Latr.) Howard, *Ann. Trl. Mus.*, I, ii, p. 124, Pl. 8, fig. e; Pl. 9, fig. e; Pl. 10, figs. e, k (1908).

R. sanguineus (Latr.) Nuttall, *Bull. Ent. Res.*, VI, iv, p. 328, f. 25-28 (1916).

This species is widely distributed in Africa, but is not very common in the Union and South-West Africa. It also occurs in Asia, Central America, West Indies and Australia. It is mainly parasitic upon dogs, and has been proved by Christophers in India to convey biliary fever to these animals. It is very common on dogs in the kennels at Onderstepoort, but has not been found on these animals elsewhere in the neighbourhood. Howard (1908) recorded it from cattle, sheep, cat and sometimes man; also from lion, jackal, genet, hare, hedgehog, lynx, pangolin and *Kobus ellipsiprymnus* (waterbuck). Adults have also been taken off *Raphiceros campestris* (steenbuck) in the Zoological Gardens, Pretoria (coll. R. Bigalke) and off *Lepus capensis* (Cape hare). Neumann has recorded it from goats; also from *Canis megalotis* and *Strix ascalaphus* (eagle owl) in Egypt, and from other animals.

12. **Rhipicephalus simus** C. L. Koch, "Black-pitted tick".

♂. *R. simus* Koch, *Arch. f. Naturg.* X, i, p. 238 (1844).

♂, ♀, ○, L. *R. simus* (Koch) Howard, *Ann. Trl. Mus.*, I, ii, p. 132, Pls. 8-10, fig. f; Pl. 11, figs. c, f, h (1908).

This species is widely distributed in Africa, and has also been recorded from Turkestan and Borneo. Adults have been taken off dogs, cattle, horses, sheep, goats, Natal warthog *(Phacochoerus sundevalli)*, duiker *(Sylvicapra grimmi)* and hyaena, Umfolosi Game Reserve, Zululand (coll. G.A.H.B., P. L. le Roux and C. C. Kent); *Strepsiceros strepsiceros* (koodoo), Kruger National Park, Transvaal (coll. A. D. Thomas); hedgehog *(Atelerix frontalis)*, Pretoria District (coll. G.A.H.B.); slender mongoose *(Myonax cauui)*, Tzaneen, Transvaal (coll. B. de Meillon); Natal cane-rat *(Thryonomys swinderianus*

variegatus), Nylstroom, Transvaal, and scaly ant-bear *(Smutsia temminckii)*, Livingstone, Northern Rhodesia. One larva has been found on Albany rock mouse *(Praomys namaquensis grahami)*, Grahamstown, C.P. (coll. J. Hewitt). Howard (1908) also recorded it from the above domestic animals and from bush pig *(Koiropotamus chocropotamus)*, Cape hunting-dog *(Lycaon pictus)*, lion, hare and hedgehog. This species has been proved to transmit East Coast fever and *Anaplasma marginale* to cattle.

13. **Rhipicephalus sulcatus** Neumann.

♂, ♀. *R. sulcatus* Neu., *Bull. Mus. Hist. Nat. Paris*, p. 352, f. 1, 2 (1908).

Specimens have been taken off red hare *(Pronolagus randensis)*, Silverton, Pretoria District (coll. R. A. Cooley). This species was described from adults collected in the Congo. Bequaert has recorded it from buffalo in the Belgian Congo.

14. **Rhipicephalus theileri** Bedford and Hewitt.

♂, ♀. *R. theileri* Bedf. & Hewitt, *S. Afr. Journ. Nat. Hist.*, V, p. 263, Pl. 20, f. 7-9 (1925).

Described from specimens taken off ground squirrel, *Geosciurus capensis* (= *Xerus capensis*) at Glen, O.F.S. Males have also been taken off hedgehog *(Atelerix frontalis)* and silver fox *(Vulpes chama)* at Petrusburg, O.F.S.

15. **Rhipicephalus tricuspis** Dönitz.

♂, ♀. *R. tricuspis* Dönitz, *Sitz.-Ber. Ges. naturf. Freunde*, p. 146, f. 7-9 (1906).

♂, ♀. *R. tricuspis* Dönitz, *Die Zecken Südafr.*, p. 479, Pl. 16B, f. 13 (1910).

♂, ♀. *R. tricuspis* (Dönitz) Nuttall, *Bull. Ent. Res.*, VI, iv, p. 332, f. 31, 32 (1916).

Recorded by Dönitz from Lehututu-Kong, Kalahari and Kamaggas, Klein-Namaqualand; also taken off cattle in Tanganyika Territory. Nuttall (1916) recorded it taken off a rabbit in the Belgian Congo.

16. **Rhipicephalus sp.**

Numerous adults attached to the ears of *Nyala angasi*, False Bay, Zululand, 14th February, 1930 (coll. G. Martinaglia).

Genus Margaropus Karsch.

Margaropus Karsch, *Mt. Münch. ent. Ver.*, III, p. 96 (1879).

Margaropus Nuttall & Warburton, *Ticks: Mon. Ixod.*, ii, p. 123, f. 128, 129 (1911).

The genus only comprises the following species:—

1. **Margaropus winthemi** Karsch, "The Argentine tick".

M. winthemi Karsch, *Mt. Münch. ent Ver.*, III, p. 96 (1879).

M. lounsburyi Neumann, *Arch. de Parasit.*, XI, p. 218 (1907).

M. lounsburyi (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 111, Pl. 7, f. a-e (1908).

This is a South American tick which must have been introduced into South Africa, possibly during the Boer War. It is common in many parts of the Orange Free State and Basutoland, and also occurs in the Graaff-Reinet District, Cape Province. Specimens have also been received taken off a horse at Impendhle, Natal, August, 1928. It is mainly parasitic upon horses, but is occasionally found on cattle.

Genus Boophilus Curtis.

Boophilus Curtis, *J. comp. Med. veter. Arch.*, XII, p. 313 (1891).

Boophilus Nuttall & Warburton, Ticks: Mon. Ixod., ii, p. 124, f. 130, 131 (1911).

This genus includes about four species.

Genotype: *Boophilus bovis* Curtis = *Ixodes annulatus* Say.

Key to the South African Species.

1. Hypostome of ♀ and ♂ with six rows of teeth, adanal shields of ♂ prolonged into strong, conical points *B. decoloratus*.

Hypostome of ♀ and ♂ with eight rows of teeth; adanal shields of ♂ variable, either square at posterior ends or slightly pointed ... ... *B. microplus*.

1. **Boophilus decoloratus** (Koch), "The Blue tick".

Rhipicephalus decoloratus Koch, *Arch. Naturg.*, X, p. 239 (1844).

Margaropus annulatus decoloratus (Koch) Neu., Das Tierreich. Ixod., p. 48 (1911).

Margaropus annulatus var. decoloratus (Koch) Howard, *Ann. Tvl., Mus.* I, ii, p. 107, Pl. VI, figs. a-o (1908).

This species is common in most parts of southern Africa, but is rare in Zululand and does not occur in some of the very arid localities. It is chiefly parasitic on cattle, horses, donkeys and mules, but also occurs on sheep, goats and occasionally on dogs. Specimens have also been taken off the following hosts in the Transvaal: *Gorgon taurinus* (blue wildebeest), Waterberg District (coll. G.A.H.B.); *Strepsiceros strepsiceros* (Cape koodoo) and *Aepyceros melampus* (impala), about 30 miles north of Messina (coll. R. A. Cooley); also off the latter host at Koedoesrand (coll. W. F. Averre) and Maasstroom (coll. B. de Meillon) in the northern Transvaal; *Damaliscus albifrons* (blesbok), Pretoria District; *Ozanna nigra* (sable antelope), Acorn Hoek; *Kobus ellipsiprymnus* (waterbuck), and *Hippotigris burchelli* (zebra); also off *Lepus zuluensis*, Pretoria District. The adults are usually found on the body and head of their hosts and the immature forms are often very plentiful in the ears. It is a one-host tick, and is a transmitting agent of the organisms producing redwater and gallsickness in cattle and spirochaetosis in cattle, sheep and horses in this country.

2. **Boophilus microplus** (Canestrini).

Haemaphysalis micropla Canestrini, *Atti. Soc. Veneto-Trent. Sic. Nat. Padova*, XI, i (1887), pp. 104, 110, Pl. 9, f. 3, 3 a-d, 5, 5 a-b (1888).

Rhipicephalus annulatus caudatus Neu., *Mém. Soc. Zool. France*, X, p. 413, f. 42 (1897).

Margaropus annulatus var. australis Fuller, *Queensl. Agric. Jour.* Brisbane. IV, v, p. 389-394, figs. (1899).

Margaropus annulatus var. australis (Fuller) Howard, *Ann. Trl. Mus.*, I, ii, p. 110, Pl. 6, figs. p-s (1908).

Boophilus microplus (Can.) Bequaert, Med. Rep. Rice-Harvard Exped. Amazon, p. 169, f. 1, 2 (1926).

This species is widely distributed and occurs in South America, Asia, Australia and South Africa. Lounsbury and Howard (1908) record it from the south-eastern districts of the Cape Province, where it is very common on cattle. It has also been proved to convey redwater to cattle.

Genus Hyalomma Koch.

Hyalomma Koch, *Arch. f. Naturg.*, X, i, p. 220 (1844).

Hyalomma Nuttall & Warburton, Ticks: Mon. Ixod., ii, p. 125, f. 132, 133 (1911).

This genus comprises four or five species.

Genotype: *Acarus aegyptius* Linnaeus.

Key to the South African Species.

1. Scutum of ♂ and ♀ reddish-brown to black in colour; eyes prominent; black; coxae i deeply bifid 2
   Scutum of ♂ and ♀ yellowish-brown to yellowish-white with deep brown lines and punctations; eyes small, whitish; coxae i conical ... ... *H. hippopotamense.*
2. Punctations on scutum of ♂ unequal, but distinct; of ♀ coarse and unequal ... ... *H. aegyptium aegyptium.*
   Punctations on scutum of ♂ coalescing, making the shield appear shagreened; of ♀ fine *H. aegyptium impressum.*

1. **Hyalomma aegyptium aegyptium** (Linnaeus). "The bont-leg tick".

Acarus aegyptius Linné, *Syst. Nat.*, ed. X, p. 615 (1758).

H. aegyptium aegyptium (L.) Neu., Das Tierreich. Ixod., p. 50 (1911).

H. aegyptium (L.) Howard, *Ann. Trl. Mus.*, I, ii, p. 99, Pl. 5, figs. e, f, n (1908).

This tick is widely distributed throughout Africa, and also occurs in southern Europe and Asia. It is rare in South Africa, except in the northern Transvaal, Swaziland and South-West

Africa. The adults are parasitic on cattle, horses, donkeys, mules, sheep, dogs and rarely on cats. Howard (1908) also records them from giraffe, camel, reedbuck, wild boar and man. Adults have also been taken off *Gorgon taurinus* (blue wildebeest), Waterberg District, northern Transvaal (coll. G.A.H.B.); *Equinus equinus* (roan antelope) north of Messina, Transvaal (coll. R. A. Cooley); *Taurotragus oryx* (eland) from South-West Africa, Zoological Gardens, Johannesburg (coll. G. Martinaglia), and *Phachochoerus aethiopicus* (African warthog) Kazungula, Bechuanaland (coll. H.M. Webb). Specimens have also been taken off *Burhinops capensis* (Cape thick-knee), Pienaar's River, Transvaal (coll. R. A. Cooley).

1A. **Hyalomma aegyptum impressum** Koch, "The South African bont-leg tick".

Hyalomma impressum Koch, *Arch. Naturg.*, X, p. 221 (1844).

H. aegyptium var. impressum Neu., *Mém. Soc. Zool. France*, XIV, p. 314 (1901).

H. aegyptium var. impressum (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 102, Pl. 5, figs. a-d, g-m, o, p (1908).

This tick is very common and widely distributed in South Africa. The adults are parasitic on cattle, equines, sheep, goats, dogs, cats, ostriches, man and duiker *(Sylviacapra grimmi)*, Umfolosi Reserve, Zululand (coll. P. L. le Roux). Immature specimens have been taken off *Lepus zuluensis (Zululand hare)* in the Pretoria District; *L. capensis*, Fort Beaufort, C.P. (coll. C. P. Lounsbury) *L. capensis ochropus*, Bloemfontein and Glen, O.F.S. (coll. R. A. Cooley); *Rattus rattus* (black rat), Onderstepoort (coll. G.A.H.B.) and *Atelerix frontalis* (hedgehog), Pretoria District (coll. G.A.H.B.) also off the following birds: Domestic fowls; thick-billed lark, *Calendula magnirostris (= C. crassirostris)*; ostriches (Howard, 1908); turkey, Bloemfontein (coll. A. J. Canham); *Bubo africanus* (Cape spotted eagle owl) and *Caffrornis caffra* (Cape robin), Onderstepoort (coll. G.A.H.B.).

2. **Hyalomma hippopotamense** (Denny).

♂. *Ixodes hippopotamense* Denny, *Ann. Mag. Nat. Hist.*, XII, p. 312, Pl. 17, f. 1 (1843).

♀. *Ixodes bimaculatus* Denny, *ibid.*, XII, p. 372, Pl. 17, f. 2 (1843).

♂, ♀. *Hyalomma hippopotamense* (Denny) Howard, *Ann. Tvl. Mus.*, I, ii, p. 104, Pl. 4, fig. m (1908).

♂, ♀. *Hyalomma hippopotamense* (Denny) Dönitz, Die Zecken Südafr., p. 455, Pl. 15, f. 1, 2, Pl. 16, f. 5 (1910).

Recorded taken off *Hippopotamus amphibius* in South and East Africa.

Genus Amblyomma Koch.

Amblyomma Koch, *Arch. f. Naturg.*, X, i, p. 223 (1844).

Amblyomma Nuttall & Warburton, Ticks: Mon. Ixod., ii, p. 26, f. 134, 135 (1911).

Amblyomma Robinson, *ibid.*, iv, pp. 1-10 (1926).

This genus is widely distributed and comprises eighty-seven species.

Genotype: *Amblyomma cajennense* (Fabricius).

Key to the South African Species.

MALES.

1. Marginal groove continuous 2
   Marginal groove incomplete or absent 6
2. Festoons appearing like overlapping folds, pale, except the second and each side of the median one, which is particoloured; rest of scutum mainly pale with a few dark markings ... ... *A. crenatum.*
   Festoons normal 3
3. Festoons entirely dark; rest of scutum dark with coppery-red areas bordered with metallic green. In preserved specimens the dark areas tend to become brownish, and the pale areas yellowish ... ... *A. variegatum.*
   Festoons not entirely dark 4
4. Festoons all pale coloured, except the external ones which are dark; rest of scutum pale greenish or yellowish, with narrow dark lines and spots ... ... *A. hebraeum.*
   Festoons particoloured; rest of scutum with dark spots and stripes on a yellowish or reddish-yellow ground, which in old specimens may become more or less obliterated ... 5
5. Scapular angles rounded; postero-median stripe on scutum much dilated at its anterior extremity ... *A. marmoreum.*
   Scapular angles pointed; postero-median stripe on scutum only slightly dilated at its anterior extremity *A. nuttalli.*
6. Scutum with dark reddish-brown markings on a dull yellow ground, punctations mainly fine with a few large ones; eyes flat ... ... *A. petersi.*
   Scutum dark brown with small pale areas only on lateral margins; eyes hemispherical, orbited ... ...*A. latum.*

FEMALES.

1. Coxa iv with one spur 2
   Coxa iv with two spurs; eyes small, hemispherical, orbited *A. latum.*
2. Eyes flat or slightly convex, not orbited 3
   Eyes hemispherical, orbited ... ... *A. variegatum.*

3. Festoons with postero-internal angles salient; scapular angles sharply pointed ... ... *A. crenatum.*
   Festoons with postero-internal angles not salient 4
4. Scutum very large (4·2 × 5·15 mm.), with very numerous fine punctations and a few large ones on latero-anterior areas ... ... *A. petersi.*
   Scutum medium (about 3 × 3 mm.), fine punctations not very numerous 5
5. Scutum with a few fine punctations only on posterior half, larger and more numerous in front ... ... *A. hebraeum.*
   Scutum with a few very large punctations scattered over the entire surface, interspersed with fine ones 6
6. Scutum with pale median area broadly rounded posteriorly *A. marmoreum.*
   Scutum with pale median area pointed posteriorly *A. nuttalli.*

1. **Amblyomma crenatum** Neumann, "The ruffled tick".

♀. *A. crenatum* Neu., *Mém. Soc. Zool. France*, XII, p. 214, f. 52 (1899).

♂. *A. subluteum* Neu., *ibid.*, p. 263 (1899).

♂, ♀. *A. crenatum* (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 145, Pl. 12, fig. i (1908).

♂, ♀. *A. crenatum* (Neu.) Robinson, Ticks: *Mon. Ixod.*, iv, p. 75, f. 32, 33 (1926).

Originally described from a female taken off *Rhinoceros*, Cape of Good Hope.

2. **Amblyomma hebraeum** Koch, "The bont tick".

♂. *Amblyomma hebraeum* Koch, *Arch. f. Naturg.* X, i, p. 225 (1844).

♂, ♀, ○, L. *A. hebraeum* (Koch), Howard, *Ann. Tvl. Mus.*, I, ii, p. 136, Pl. 12, figs. a-h (1908).

♂, ♀. *A. hebraeum var. eburneum* Howard, *ibid.*, I, ii, p. 139 (1908), *nec Gerstäcker*, 1873.

♂, ♀. *A. hebraeum* (Koch) Robinson, *Mon. Ixod.*, iv, p. 104, t.f. 3, Pl. 1, f. 1, 2 4; Pl. 3, f. 1, 2 (1926).

This species is widely distributed in the Union, but occurs more frequently on the low veld than on the high veld. It has also been recorded from Mozambique, Bechuanaland (Jack, 1928) and Tanganyika Territory. It is parasitic upon cattle, horses, donkeys, mules, sheep, goats and dogs. Howard (1908) has also recorded it from man, *Giraffa camelopardalis*, *Lycaon pictus* (Cape hunting dog), buffalo and elephant. Adults and nymphs have been taken off *Sylviacapra* grimmi (duiker), adults off *Syncerus caffer* (buffalo) and nymphs of *Thryonomys swinderianus variegatus* (Natal cane-rat) in the Umfolosi Reserve, Zululand (coll. P. L. le Roux). Adults have also been taken off domestic pig, Klasserie, Transvaal (coll. R. A. Cooley); *Nyala angasi* (nyala), Ubombo Flats, Zululand (coll. D. T. Mitchell);

both the black rhinoceros and white rhinoceros, *Phachochoerus sundevalli* (Natal warthog) and *Gorgon taurinus* *Phachoehoerus sundevalli* (Natal warthog) and *Gorgon taurinus* (blue wildebeest), Umfolosi, Zululand (coll. A. B. M. Whitnall and C. C. Kent). Larvae occasionally get on to man and have also been taken off *Micropelis nigripes* (black-footed cat), Thornkloof, Albany District, C. P. (sent by J. Hewitt), and nymphs off *Lepus zuluensis*, Hartebeestpoort, near Pretoria (coll. G.A.H.B.) and off *Mungos mungo* (banded mongoose), Umfolosi Reserve, Zuluand (coll. P. L. le Roux). Immature forms are also occasionally found on birds, including fowls and ostriches. It is the transmitting agent of heartwater to cattle, sheep and goats in South Africa. The bites of the adult ticks also frequently cause swellings, which lead to suppuration.

3. **Amblyomma latum** (Koch).

♂. *Hyalomma latum* Koch, *Arch. f. Naturg.*, X, i, p. 221 (1844).
♀. *Hyalomma devium* Koch, *ibid.*, X, i, p. 222 (1844).
♂. ♀. *Amblyomma sylvaticum* (De Geer) Neumann, *Mém. Soc. Zool. France*, XII, p. 274 (1899).
♂, ○. *A. sylvaticum* (De Geer) Bedf. & Hewitt, *S. Afr. Journ. Nat. Hist.* V, i, p. 265, Pl. 20, f. 10, 11 (1925).
♂, ♀. *A. latum* Robinson, Ticks: *Mon. Ixod.*, IV, p. 151, f. 69, 70 (1926).

Reported taken from a tortoise, Cape of Good Hope. Bedford and Hewitt (1925) recorded it taken off a tortoise, *Testudo angulata* at Éssendene in the Alexandria District, C.P., and from the same host at Malmesbury, C.P.; also from tortoises and a mole-snake *(Pseudaspis eana)* at Port Elizabeth, C.P.

4. **Amblyomma marmoreum** Koch.

♂. *Amblyomma marmoreum* Koch, *Arch. f. Naturg.* X, i, p. 224 (1844).
♂, ♀, ○, L. *Amblyomma marmoreum* (Koch) Howard, *Ann. Trl. Mus.*, I, ii, p. 142, Pl. 12, figs. m, n; Pl. 13, figs. c-k (1908).
♂, ♀. *Amblyomma marmoreum* (Koch) Robinson, Ticks: *Mon. Ixod.*, iv, p. 86, f. 38, 39 (1926).

This tick has been recorded from the Cape Province, Transvaal, Upper Zambesia, Zanzibar, Kenya Colony, Uganda, Nyasaland, Tanganyika Territory, Belgian Congo, Senegal, Algeria and Sudan. It is common on tortoises in the Transvaal, and has been found on rhinoceros in various parts of Africa. Neumann (1911) recorded it taken off *Genetta pardina*, and Robinson (1926) from a tortoise, *Testudo leopardinus* * in South Africa. Adults have also been taken off *Testudo pardalis* in the Pietersburg District, Transvaal. Larvae and nymphs are reported to feed readily on ox and goat, and on some kinds of birds and lizards (Howard, 1908).

* No such species known; probably *Testudo pardalis*.

5. **Amblyomma nuttalli** Dönitz.

♂, ♀. *Amblyomma nuttalli* Dönitz, *Sitzungsber. der Gesellsch. naturforsch. Freunde,* No. 8, p. 469, f. 4 (1909).

♂, ♀. *Amblyomma nuttalli* (Dönitz) Robinson, Ticks: *Mon. Ixod.*, iv, p. 90, f. 40, 41 (1926).

This species has been recorded by Robinson (1926) taken off tortoise, Varanus or Emys and hedgehog from the following countries: Southern Rhodesia, Uganda, Tanganyika Territory, Cameroons, Southern Nigeria and Gold Coast. Specimens have been bred on *Testudo pardalis* at Onderstepoort from adults taken off a tortoise in the Zoological Gardens, Pretoria, and males have been taken off *Python sebae*, Zululand (coll. A. D. Thomas).

6. **Amblyomma petersi** Karsch.

♂. *Amblyomma petersi* Karsch, *Monatsber. Kak. Wissensch. Berlin*, p. 336, Pl. 1, f. 4 (1873).

♀. *Amblyomma aureum* Neumann, *Mém. Soc. Zool. de France*, XIV, p. 254, f. 56 (1899).

♂. *Amblyomma foai* Neumann, *ibid.*, XIV, p. 262 (1899).

♂, ♀. *Amblyomma petersi* (Karsch) Robinson, Ticks: *Mon. Ixod.*, iv, p. 260, f. 128, 129 and Pl. 4, f. 1 (1926).

Recorded by Bedford and Hewitt (1925) taken off *Ceratotherium simum* (white rhinoceros), Umfolosi Game Reserve, Zululand; *Diceros bicornis* (black rhinoceros), Hhuhluwe Game Reserve and Mduna River, Zululand; also off a rhinoceros at Punda Milia, Kenya Colony. It is mainly a parasite of rhinoceros, and has also been found on grass and on *Antilope oreas*. It has been recorded from the following countries: Mozambique, Zanzibar, Madagascar, Tanganyika Territory, Kenya Colony, Uganda, Nyasaland and Liberia.

7. **Amblyomma variegatum** (Fabricius).

♂. *Acarus variegatus* Fabr. *Ent. syst., Suppl.*, p. 353 (1794).

♂. *Amblyomma venustum* Koch, *Arch. f. Naturg.*, X, i, p. 224 (1844).

♂, ♀. *Amblyomma variegatum* (Fabr.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 140, Pl. 12, figs. k, l; Pl. 13, figs. a, b (1908).

♂, ♀. *Amblyomma variegatum* (Fabr.) Robinson, Ticks: *Mon. Ixod.*, iv, p. 101, f. 4 and Pl. 2, f. 1-4 (1926).

Recorded by Howard (1908) from the Transvaal and Cape Province, but Mr. Lounsbury informs me that the specimens from the latter locality were bred by him from adults obtained from Rhodesia. Specimens have been taken off the following hosts in the Transvaal: Cattle, goat at Acorn Hoek and dogs at Klasserie (coll. R. A. Cooley). It is very widely distributed in Africa, and Robinson (1926) also recorded it from South-West Africa and Portuguese East Africa. It has been found on cattle,

sheep, horse, donkey, dog, cat, goat, camel, zebra, elephant, rhinoceros, wart-hog, buffalo, waterbuck, eland, congoni, Jackson's hartebeest, sable antelope, reedbuck, bushbuck and man. Adults have also been taken off three spurwing geese *(Plectropterus gambensis)*, Mazabuka, Northern Rhodesia (coll. P. L. le Roux). This species is capable of transmitting heartwater to cattle, sheep and goats in Kenya Colony.

Genus Aponomma Neumann.

Aponomma Neumann, *Mém. Soc. Zool. France*, XII, p. 180 (1899).

Aponomma Nuttall and Warburton, Ticks: Mon. Ixod., iv, p. 126 (1911).

Neumaniella Lahille.

This genus contains about thirteen species parasitic on reptiles in various parts of the world.

Key to the South African Species.

Aponomma globulus (Lucas) is not included in the key.

1. Scutum uniformly reddish-brown 2
   Scutum of ♂ with nine and of ♀ with three metallic green spots ... ... *A. exornatum.*
2. Anal groove absent; scutum of ♂ and body of ♀ broader than long ... ... *A. transversale.*
   Anal groove present; scutum of ♂ and body of ♀ not broader than long ... ... *A. laeve capensis.*

1. **Aponomma exornatum** (Koch).

Amblyomma exornatum Koch, *Arch. Naturw.*, X, p. 231 (1844).

Ixodes flavomaculatus Lucas, *Ann. Soc. ent. France*, (2) IV, p. 56, Pl. 1, f. 1 (1846).

Ixodes varani Lewis, *Journ. Quekett Club*, (2) V, p. 10, Pl. 1 (1892).

♂, ♀, ○, L. *Aponomma exornatum* (Koch) Howard, *Ann. Trl. Mus.*, I, ii, p. 148, Pl. 14, fig. a-i; Pl. 15, fig. a-c, f (1908).

This tick is very common on the iguana *(Varanus niloticus)* in South Africa. Howard (1908) has also recorded it from *Python sebae* and a dog (abnormal host). Males have also been taken off *Varanus albigularis*, Pretoria. It is widely distributed in Africa, having also been recorded from Tanganyika Territory, Madagascar, Congo, Senegal and Algeria.

2. **Aponomma globulus** (Lucas).

♀. *Ixodes globulus* Lucas, *Ann. Soc. ent. France*, (3), VIII, p. 538 (1860).

♀. *Aponomma globulus* (Lucas) Neumann, *Das Tierreich, Ixod.*, p. 97 (1911).

Described from female taken off *Python sebae* in South Africa.

3. **Aponomma laeve capensis** Neumann.

♂, ♀. *Aponomma laeve var. capense* Neu., *Mém. Soc. Zool. France*, XIV, p. 291 (1901).

♂, ♀, ○, L. *Aponomma laeve var. capense* (Neu.) Howard, *Ann. Tvl. Mus.*, I, ii, p. 150, Pl. 15, figs. d, e, g, h, i (1908).

Described by Neumann from specimens taken off *Ophidia* (genus ?), Cape of Good Hope. Howard (1908) recorded it from mamba *(Dendraspis angusticeps)*, Transvaal and other snakes. Males have also been taken off ringhals *(Sepedon haemachates)*, Ntambanana, Zululand (coll. G.A.H.B.) and a female off Cape cobra *(Naia flava)*, Port Elizabeth (coll. Fitz Simmons).

4. **Aponomma transversale** (Lucas).

Ixodes transversalis Lucas, *Rev. Zool.*, VII, p. 49 (1844).

Neumaniella transversale (Lucas) Howard, *Ann. Tvl. Mus.*, I, ii, p. 154, Pl. 16, figs. n (a-d) (1908).

Recorded found in the eye-sockets of *Python sebae*, South Africa.

Order DERMAPTERA.

Family HEMIMERIDAE.

This is a small family containing only two known species, both belonging to the genus *Hemimerus*. They have been found on the giant rat *(Cricetomys gambianus)* in various parts of Africa, but it is not known whether they are parasitic or not. The species are apterous, without eyes. Thoracic nota large. Abdomen elongate, with a pair of long, feebly chitinized, unjointed, hairy cerci at the apex. Legs with the coxae small, widely separated; tarsi three-jointed. Females viviparous.

Genus Hemimerus Walker.

1. **Hemimerus talpoides** Walker.

Hemimerus talpoides (Walker) Carpenter, *Ent. Mo. Mag.* (2), XX, pp. 254-257, Pl. 4, f. 1-4 (1909).

Hemimerus talpoides (Walker) Jordan, *Nov. Zool.*, VI, (1909).

A number of specimens have been collected from *Cricetomys gambianus* in the Zoological Gardens at Pretoria (coll. A. K. Haagner). This species was described from specimens taken off the same host in Sierra Leone.

The second species, *H. hanseni* Sharp, has been recorded from the same host in Cameroon, Uganda and Mocambique (?).

Order ANOPLURA.

This order includes the biting and sucking lice. They are small, apterous insects, 1 to 10 mm. in length, and live as permanent ectoparasites on birds and mammals. Antennae short, three to five-jointed. Eyes present or absent; ocelli absent. Mouth-parts adapted for either biting or sucking. Thoracic segments may be either

distinct or fused. Legs short, tarsi one to two-jointed. Abdomen usually consisting of nine segments, but the number vary; tergal and sternal sclerites frequently present; cerci absent.

The females attach their eggs or nits to either the hairs or feathers of the hosts, and in the case of *P. humanus corporis* of man to the clothing.

The immature forms resemble the adults, except that they are smaller and less highly chitinous.

Key to the Suborders.

1. Mandibles present 2
   Mandibles absent; mouth-parts terminal, formed for sucking, thorax unsegmented; tarsi 1-jointed; claws single. Parasitic on mammals ... ... *Siphunculata*, p. 398.
2. Head not produced into a proboscis; mouth-parts ventral; maxillary palpi four-jointed or absent; prothorax usually free (always in South African species); meso and metathorax frequently fused; tarsi one or two-jointed; claws single or paired; parasitic on birds and mammals *Mallophaga.*
   Head produced into a proboscis, with mouth-parts at apex; mandibles small; prothorax small, free; meso and metathorax fused; claws single. Parasitic on elephants *Rhyncophthirina*, p. 398.

Suborder MALLOPHAGA.

In 1908 Kellogg listed 1,250 species, and in 1916 the described species were catalogued by Harrison, who listed 1,520 as valid. Since then a number of new species has been described. They are mainly parasitic on birds, but a number are found on mammals.

Of the two superfamilies, Harrison (1916) regarded the Amblycera as being more primitive than the Ischnocera, but we consider that the former are more specialized than the latter for the following reasons: Firstly, the species of Amblycera resemble the Siphonaptera, which are considered specialized ectoparasites, in possessing grooves on the head for the protection of the antennae and, secondly, a number of the species are also specialized in possessing either patches of setae or combs of minute spines on some of the abdominal sternites and hind femora. Those on the sternites being no doubt used by the insects for cleaning their hind legs; those on the hind femora for cleaning the mid legs, the mandibles no doubt being used to clean their fore-legs. Moreover, the most primitive species (*nov. gen. et sp.*) I have seen is of the *Lipeurus* type. Unfortunately its host is unknown.

It is also interesting to note that species of the *Lipeurus* type are only known to be parasitic on the older types of birds, including the Struthiones. Those of the *Degeeriella* and *Philopterus* types are common on the more recent types of birds, including the Passerines, and are also parasitic on the ancient forms, with the exception of Struthiones, Galliformes and Columbiformes. The species of Menoponidae are likewise found on the majority of birds, except Struthiones, and also occur on marsupials.

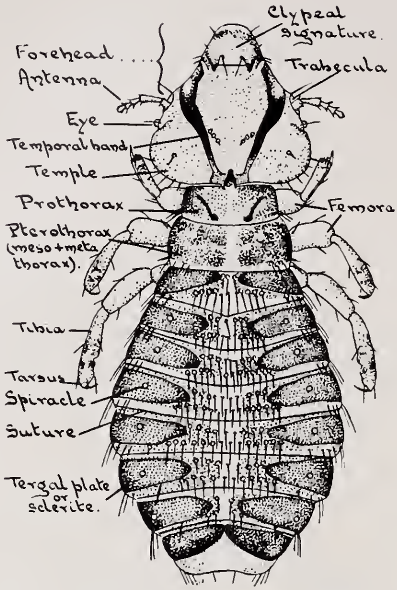


Fig. 12. *Neophilopterus abdimius* Bedford, female.

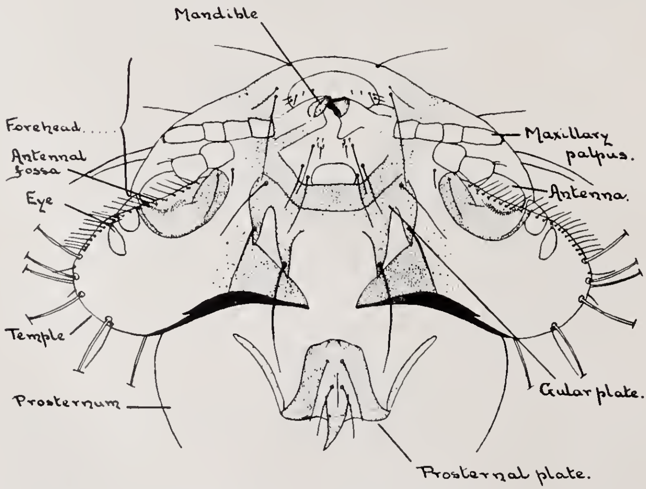


Fig. 13. *Machaerilaemus urocolius* Bedford, venter of head and prosternum of female.

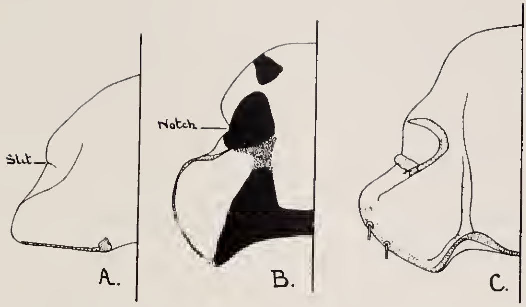


Fig. 14. Outlines of one side of head of: A, *Menopon gallinae* (Linné); B, *Colpocephalum zebra* Nitzsch; C, *Dennyus* sp.

Key to the Superfamilies.

1. Antennae filiform and always exposed; maxillary palpi wanting ... ... *Ischnocera.*
   Antennae swollen towards their apices and when in repose largely concealed in grooves; maxillary palpi present *Amblycera*, p. 367.

Superfamily ISCHNOCERA.

The species belonging to this superfamily are mainly found either attached to the feathers of birds or to the hairs of mammals.

Key to the South African Families.

1. Tarsi with two claws; prothoracic spiracles absent; antennae five-jointed in both sexes. Parasitic on birds *Philopteridae.*
   Tarsi with one claw; prothoracic spiracles present; antennae of ♂ three-jointed, of ♀ three to five-jointed. Parasitic on mammals ... ... *Trichodectidae*, p. 356.

Family PHILOPTERIDAE.

Harrison (1916) divided this family into six subfamilies, but we agree with Ewing (1929) that they should be discarded for the present.

Key to the South African Genera.

1. Head symmetrical. Not on Struthiones 2
   Head asymmerical, the incrassations on lateral margins of forehead different on the two sides; right mandible with a large basal process. On ostriches *Struthiolipeurus*, p. 314.
2. Forehead with 4 to 6 or more circular incrassations on the lateral margins. On Falconiformes *Falcolipeurus*, p. 315.
   Forehead without such incrassations 3

3. Forehead rounded with a narrow marginal band; clypeal suture and plate (signature) absent 4
Forehead rarely rounded, without a complete or almost complete marginal band; clypeal suture and plate usually present; anterior margin of clypeus frequently hyaline 12
4. Temples rounded 5
Temples angulate 10
5. Antennae different in both sexes; the first joint of ♂ larger than in the ♀, first and third joints of ♂ with or without an appendage 6
Antennae similar in both sexes 9
6. Pterothorax shorter than prothorax with lateral margins rounded. Third joint of ♂ antenna without appendage. On bustards .. .. *Otidoecus*, p. 318.
Pterothorax longer than prothorax; third joint of ♂ antenna with an appendage (except in *L. waterstoni*) 7
7. Parameres of ♂ genitalia curved, projecting outwards. On Coliidae and Ploceidae ... ... *Colilipeurus*, p. 317.
Parameres of ♂ genitalia not projecting outwards 8
8. Basal plate of ♂ genitalia very short and broad; parameres fused. On bustards ... ... *Otilipeurus*, p. 317.
Basal plate of ♂ genitalia not very short and broad; parameres not fused. On Galliformes ... *Lipeurus*, p. 316.
9. Tergal sclerites I to VII interrupted in the middle. On sandgrouse ... ... *Syrrhaptoecus*, p. 318.
Tergal sclerites complete. Chiefly on Falconiformes *Degeeriella (sens. str.)*, p. 319.
10. Temples produced backwards into spine-tipped angular processes. On penguins ... ... *Austrogoniodes*, p. 332.
Temples not produced backwards into spine-tipped processes. On Galliformes and Columbidae 11
11. Third segment, and sometimes the first, of ♂ antenna with an appendage ... ... *Goniodes*, p. 329.
First and third segments of ♂ antenna without an appendage *Goniocotes*, p. 331.
12. Species elongated, narrow; trabeculae small or absent ... 13
Species short and broad; trabeculae usually large and movable 20
13. Antennae different in both sexes, the first joint of ♂ larger than in the ♀; first and third joints of ♂ with or without an appendage 15
Antennae similar in both sexes 14
14. Forehead deeply notched in front. On Anatidae *Acidoproctus*, p. 333.
Forehead not notched in front. On various birds *Degeeriella (sens. lato)*, p. 319.

15. Large species (8·5-9 mm.); clypeal plate broader than long; first joint of ♂ antenna with an appendage; trabeculae absent. On Diomedeidae ... ... *Harrisoniella*, p. 333.

Species smaller; clypeal plate not broader than long; first joint of ♂ antenna usually without an appendage; trabeculae usually present 16

16. Forehead with a chitinous transverse band behind clypeal suture 17

Forehead without such a band 19

17. Chitinous band behind clypeal suture entire; ♂ genitalia symmetrical. On Hydrobatidae ... *Pseudonirmus*, p. 334.

Chitinous band behind clypeal suture interrupted in the middle, where each half turns backwards 18

18. Forehead longer than hind head. On Hydrobatidae and Diomedeidae ... ... *Naubates*, p. 334.

Forehead shorter than hind head. On gannets, cormorants, frigate, tropic and snake birds; also pelicans
Pectinopygus, p. 335.

19. Clypeus with two pairs of spines on dorsum, one being flattened and porrect, and the other recurved. On pigeons ... ... *Columbicola*, p. 341.

Clypeus without such spines. On various birds
Esthiopterum, *p.* 337.

20. Forehead with a membranous flap projecting beyond the lateral margins of the head and very conspicuous in the ♂ 21

Forehead without laterally projecting membranous flap 22

21 Antennae different in both sexes. On Hydrobatidae
Trabeculus, p. 343.

Antennae similar in both sexes. On Hydrobatidae
Giebelia, p. 343.

22. Antennae different in both sexes 23

Antennae similar in both sexes 24

23. ♀ : inner margin of pleura of eighth abdominal segment with a process bearing two or more spines; ♂ second and third antennal segments normal. On Rallidae
Rallicola, p. 341.

♀ : inner margin of pleura of eighth abdominal segment without spine-bearing processes; ♂ : first three antennal segments very elongated. On Diomedeidae
Docophoroides, p. 344.

24. Clypeal plate divided, consisting of two oblong plates. On ibises and spoonbills ... ... *Ibidoecus*, p. 345.

Clypeal plate not divided 25

25. Clypeal plate with a backward-projecting process at each latero-posterior angle; tergal sclerites duplicated; interrupted in the middle. On Ciconiidae *Neophilopterus*, p. 345.

Clypeal plate without processes at the latero-posterior angles 26

26. Tergal sclerites complete and fused with the pleurites in both sexes. On Scolopacidae * ... ... *Dollabella*, p. 347.

Tergal sclerites interrupted in the middle 27

27. Hyaline area of clypeus with a deep median notch. On water birds ... ... *Incidifrons*, p. 346.

Clypeus without a median notch dividing the hyaline area ... 28

28. Clypeal region expanded, with free margin hyaline throughout 29

Clypeal region without an expanded hyaline margin 30

29. Clypeal region rounded in front; a pair of small peg-like spines dorsally behind clypeal suture. On Anatidae *Anatoecus*, p. 346.

Clypeal region emarginate in front, and with a tuft of three or more setae dorsally on each lateral band. Chiefly on cuckoos ... ... *Cuculoecus*, p. 347.

30. Forehead irregularly rounded; trabeculae reduced, immovable, not reaching apex of first antennal segment. On owls ... ... *Eustrigiphilus*, p. 347.

Forehead more or less rectangular with lateral margins somewhat emarginated; trabeculae larger and usually movable. On various birds, including owls *Philopterus*, p. 348.

Genus Struthiolipeurus Cummings.

Struthiolipeurus Cummings, *Proc. Zool. Soc. Lond.*, p. 679 (1916).

Genotype: *Lipeurus asymmetricus* Piaget = *Esthiopterum rheae* Harrison.

1. **Struthiolipeurus struthionis** (Gervais).

Lipeurus struthionis Gerv., *Aptères*, III, p. 354, Pl. 9, f. 2 (1847).

Lipeurus quadrimaculatus Piaget, *Pédiculines*, p. 298, Pl. 24, f. 8 (1880).

Esthiopterum struthionis (Gerv.) Harrison, *Parasit.*, IX, i, p. 142 (1916).

Bedford (1919) recorded this species taken off *Struthio australis* (southern ostrich) at Onderstepoort. It was described by Piaget from specimens taken off *Struthio camelus* and *Rhea americana* in the Zoological Gardens at Rotterdam.

*A few species at present included in the genus *Philopterus* will be found to run down to here. They are, however, not parasitic on Scolopacidae.

Genus FALCOLIPEURUS Bedford.

Falcolipeurus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 290 (1931).

This genus contains thirteen species found on Falconiformes.

Genotype: *Lipeurus secretarius* Giebel.

1. **Falcolipeurus africanus** Bedford.

Falcolipeurus africanus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 291, f. 9, 12, 15 (1931).

Described from specimens taken off *Pseudogyps africanus fulleborni* (southern white-backed vulture) in the Rustenburg District, Transvaal.

2. **Falcolipeurus lineatus** Bedford.

Falcolipeurus lineatus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 292, f. 10, 13, 16 (1931).

Described from specimens taken off *Terathopius ecaudatus* (bateleur eagle) in the Rustenburg District, Transvaal; also a ♂ and ♀ (possibly stragglers) from *Gyps coprotheres* (Cape vulture) in the same district.

3. **Falcolipeurus monilis** (Nitzsch).

Lipeurus monilis Nitzsch in Giebel, *Zeit. f. ges. Nat.*, XVII, p. 519 (1861).

Lipeurus frater Giebel, *Ins. Epiz.*, p. 210 (1874).

Described by Giebel (1874) from specimens taken off *Neophron percnopterus* (Egyptian vulture). The type host is *N. monachus.*

4. **Falcolipeurus quadripustulatus** (Nitzsch).

Lipeurus quadripustulatus Nitzsch, in Burmeister, *Handb.*, II, p. 434 (1838).

Lipeurus quadripustulatus (N.) Giebel, *Ins. Epiz.*, p. 208, Pl. 17, f. 5 (1874).

Recorded by Piaget (1880) from *Gyps rüppelli* (Rüppell's vulture). The type host is *Vultur cinereus.*

5. **Falcolipeurus secretarius** (Giebel).

Lipeurus secretarius Giebel, *Ins. Epiz.*, p. 213 (1874).

Lipeurus secretarius (Giebel) Piaget, *Pédiculines*, p. 292, Pl. 24, f. 2 (1880).

Falcolipeurus secretarius (Giebel) Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 291, f. 8, 11, 14 (1931).

Recorded by Waterston (1914) taken off the type host, *Sagittarius serpentarius* (secretary bird) in South Africa. It has also been taken off the same host in the Rustenburg District.

Genus LIPEURUS Nitzsch.

Lipeurus Nitzsch, *Germar's Magazin*, III, p. 292 (1818).

This genus includes about forty-seven species found on Galliformes and South American tinamous.

Genotype: *Pediculus caponis* Linné.

1. **Lipeurus caponis** (Linné).

Pediculus caponis Linné, *Syst. Nat., p.* 614 (1758) .

Lipeurus variabilis Nitzsch in Burmeister, *Handb.*, II, p. 434 (1838).

Lipeurus variabilis (Nitz.) Piaget, *Pédiculines,* p. 364, Pl. 29, f. 4 (1880).

Recorded by Bedford (1919) taken off a domestic fowl at Pietermaritzburg, Natal.

2. **Lipeurus gallipavonis** (Geoffroy).

Pediculus gallipavonis Geoff., *Hist. Abr. Ins.*, p. 600 (1762).
Lipeurus polytrapezius Nitzsch, in Burmeister, *Handb.*, II, p. 434 (1838).

Lipeurus polytrapezius (Nitz.) Piaget, *Pédiculines,* p. 367, Pl. 29, f. 6 (1880).

Specimens have been taken off a domestic turkey at Pietermaritzburg, Natal (coll. L. Hill).

3. **Lipeurus heterographus** Nitzsch.

L. heterographus Nitz., in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 381 (1866).

L. obscurus Giebel, *Ins. Epiz., p.* 220 (1874).

L. heterographus (Nitz.) Piaget, *Pédiculines*, p. 360, Pl. 29, f. 2 (1880).

A common parasite of the domestic fowl in South Africa.

4. **Lipeurus lawrensis** Bedford.

L. lawrensis Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 521, f. 22-24 (1929).

Described from a ♂ and ♀ taken off a guinea-fowl, *Numida papillosa*, on the Kunene River, South-West Africa.

5. **Lipeusus pternistis** Bedford.

L. pternistis, Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, p. 522, f. 25, 25A, 26 (1929).

Described from specimens taken off *Pternistis swainsoni* (Swainson's red-necked francolin) in the Zoological Gardens, Pretoria, and *Pternistis afer* (Angola red-necked francolin). Kunene River, South-West Africa.

6. **Lipeurus tropicalis** Peters.

Lipeurus tropicalis Peters, *Ent. News*, XLII, vii, p. 195, f. 1, 2 (1931).

One ♂ taken off domestic fowl at Onderstepoort (coll. G.A.H.B.). Described by Peters from specimens taken off domestic fowls in Bahama Islands, Caicos Islands, Venezuela and Liberia; also recorded by him from five species of wild guinea-fowls from Africa.

7. **Lipeurus watersoni** Bedford.

L. waterstoni Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust.*, XVI, p. 165, f. 8 a-d (1930).

Described from specimens taken off *Scleroptila gariepensis pallidior* (Ovambo partridge)*, Kunene River, South-West Africa.

Genus Colilipeurus Bedford.

Colilipeurus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVI, p. 167 (1930).

This genus includes three species found on Coliidae and Ploceidae. Their presence on a weaver bird was most probably due to straggling.

Genotype: *Esthiopterum colius* Bedford.

1. **Colilipeurus colius** (Bedford).

Esthiopterum colius Bedford, *Rept. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 731, Pl. 7, f. 1, 2 (1920).

Described from specimens taken off *Urocolius indicus transvaalensis* (Transvaal red-faced coly). Specimens have also been taken off *U. indicus lacteifrons* (Damara red-faced coly), Khan River, South-West Africa (coll. R. D. Bradfield). The transverse abdominal markings shown in the figure are ventral, not dorsal. They are absent in the specimens from Khan River, which are probably slightly immature.

Genus Otilipeurus Bedford.

Otilipeurus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 287 (1931).

This genus comprises three species found on Otidae.

Genotype: *Lipeurus turmalis* Nitzsch.

1. **Otilipeurus kori** Bedford.

O. kori Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 289, f. 6, 7a (1931).

Described from a ♀ and ♂ taken off *Choriotis kori* (giant bustard) in the Rustenburg District, Transvaal.

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* Mr. Roberts has examined the skin and informs me that it is *Scleroptila jugularis.*

Genus Otidoecus Bedford.

Otidoecus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 285 (1931).

This genus contains a single species.

1. **Otidoecus dimorphus** Bedford.

O. dimorphus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 285, f. 4, 5, 7b (1931).

Described from specimens taken off *Choriotis kori* (giant bustard) at Kwambonambi, Zululand.

Genus Syrrhaptoecus Waterston.

Syrrhaptoecus Waterston, *Proc. Zool. Soc. Lond.*, ii, pp. 337-338 (1928).

This genus includes thirteen species found on sand-grouse (Pteroclidae).

1. **Syrrhaptoecus brevifrons** Waterston.

Syrrhaptoecus brevifrons Waterston, *Proc. Zool. Soc., Lond.*, ii, pp. 339-342, f. 1b, 7 (1928).

This species was described from specimens taken off *Pterocles namaquus* (Namaqua sand-grouse) in the Rustenburg District, Transvaal, 3rd September, 1917; also from *Eremialector quadricinctus* Temm. in the Sudan, and off *Eremialector coronatus* Licht., Muscat.

2. **Syrrhaptoecus declivis** Waterston.

Syrrhaptoecus declivis Waterston, *Proc. Zool. Soc., Lond.*, ii, p. 348, f. 5b, 9e (1928).

Described from males and females taken off double-banded sand-grouse, *Nyctiperdix bicinctus (= Eremialector bicinctus)* from Angola.

3. **Syrrhaptoecus digonus** Waterston.

Syrrhaptoecus digonus Waterston, *Proc. Zool. Soc., Lond.*, ii, p. 345, f. 3a, 8b, 10c (1928).

Described from specimens taken off *Ptcrocles namaquus* (Namaqua sand-grouse) at Klipfontein, Little Namaqualand; Deelfontein, C.P., and in the Rustenburg District, Transvaal. Recorded by Bedford (1929) taken off the same host on the Kunene River, S.W.A., March, 1923.

4. **Syrrhaptoecus uncinosus** Waterston.

Syrrhaptoecus uncinosus Waterston, *Proc. Zool. Soc., Lond.*, ii, p. 350, f. 4b, 8d, 10a (1928).

Described from specimens taken off *Eremialector gutturalis* (yellow-throated sand-grouse) and *var. saturatior* Hart. from S. Abyssinia and T.T. Simba. The variety *saturatior* does not occur in South Africa.

Genus Degeeriella Neumann.

Nirmus Nitzsch, *Germar's Magazin*, III, p. 291 (1818), *nec.* Hermann, 1804.

Degeeriella Neumann, *Bull. Soc. Zool. France*, XX, p. 59 (1906). Harrison (1916) catalogued 266 species, but this genus will eventually be split up into a number of genera.

Genotype: *Nirmus discocephalus* Nitzsch.

1. **Degeeriella actophila** (Kellogg and Chapman).

Nirmus actophilus Kell. & Chap., *New Mallophaga*, III, p. 78, Pl. 6, f. 4 (1899).

Recorded by Bedford (1920) from curlew sandpiper, *Erolia testacea (= Tringa subarquata)*, Lamberts Bay, Cape Province, and *Pisobia minuta* (little stint) in the Pretoria District, Transvaal. It was described from specimens taken off *Calidris arenaria* in California.

2. **Degeeriella alpha** (Kellogg).

Nirmus triangulatus var. alpha Kell., *Brooklyn Sci. Bull.*, II, iv, p. 84 (1914).

Recorded from southern skua, *Catharacta skua antarticus (= Megalestris antartica)* in the South Tropical Atlantic, and from broad-billed blue petrel, *Cymochorea leucorhoa (= Oceanodroma leucorhoa)* in the North Tropical Atlantic. Both hosts occur on the South African coast.

3. **Degeeriella apiastri** (Denny).

Nirmus apiastri Denny, *Anoplur. Brit.*, p. 133, Pl. 10, f. 4 (1842).

Nirmus apiastri Piaget, *Pédiculines*, p. 158, Pl. 13, f. 11 (1880).

Described from specimens taken off *Merops apiaster* (European bee-eater).

4. **Degeeriella assimilis** (Piaget).

Nirmus assimilis Piaget, *Proc. Ent. Soc. Lond.*, p. XXIII (1890).

Described from specimens taken off Caspian plover, *Eupodella asiatica (= Aegialitis asiatica)*, a migrant to South Africa.

5. **Degeeriella bicurvata** (Piaget).

Nirmus bicurvatus Piaget, *Pédiculines*, p. 159, Pl. 13, f. 18 (1880).

Described from specimens taken off paradise widowbird, *Steganura paradisea (= Vidua paradisea)*, in the Leyden Museum.

6. **Degeeriella bipunctata** (Rudow).

Nirmus bipunctatus Rudow, *Zeit. f .ges. Nat.*, XXXV, p. 466 (1879).

Described from specimens taken off pied crow, *Corvus albus (= C. scapulatus)*.

7. **Degeeriella brevipes** (Piaget).

Nirmus brevipes Piaget, *Pédiculines*, p. 179, Pl. 15, f. 3 (1880).

Described from specimens taken off curlew sandpiper, *Erolia testacea (= Tringa subarquata).*

8. **Degeeriella brunnea** (Nitzsch).

Nirmus brunneus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 373 (1866).

Described from specimens taken off *Dromas ardeola* (crab plover), a migrant to South Africa.

9. **Degeeriella cingulata** (Nitzsch).

Nirmus cingulatus, Nitzsch, in Denny, *Anoplur. Brit.*, p. 146, Pl. 11, f. 3 (1842).

N. cingulatus (Nitz.) Piaget, *Pédiculines*, p. 187, Pl. 16, f. 9 (1880).

Described by Denny from specimens taken off black-tailed godwit, *Limosa limosa (= L. melanura).* Piaget (1880) also recorded it from the sanderling, *Crocethia alba (= Calidris arenaria)* and little stint, *Pisobia minuta (= Tringa minuta).* All these hosts are migrants to South Africa.

10. **Degeeriella colymbina** (Scopoli).

Pediculus colymbinus Scopoli, *Ent. Carn.*, p. 384 (1763).

Nirmus fuscomarginatus Denny, *Anoplur. Brit.*, p. 136, Pl. 10, f. 1 (1842).

Nirmus fuscomarginatus (Denny) Piaget, *Pédiculines*, p. 202, Pl. 16, f. 6 (1880).

Recorded by Bedford (1920) as reported to have been taken off *Phalacrocorax lucidus* in the Rustenburg District, Transvaal, but it was undoubtedly taken off a grebe. Also recorded by Bedford (1929) from *Proctopus nigricollis gurneyi* (Cape eared grebe), Tamanzu, South-West Africa.

This species was described by Denny taken off *Podiceps auritus* in Ireland, and Piaget (1880) recorded it from *Podiceps cristatus* (crested grebe), to which an allied species occurs in South Africa.

11. **Degeeriella complexiva** (Kellogg and Chapman).

Nirmus complexivus Kell. & Chap., *New Mallophaga*, III, p. 75, Pl. 6, f. 3 (1899).

Described from specimens taken off sanderling, *Crocethia alba (= Calidris arenaria)*, a migrant to South Africa.

12. **Degeeriella cruciata** (Burmeister).

Nirmus cruciatus Burmeister, *Handb.* II, p. 429 (1838).

Described from specimens taken off red-backed shrike, *Enneoctonus collurio (= Lanius collurio)*, a migrant to South Africa.

13. **Degeeriella decipiens** (Nitzsch).

Nirmus decipiens Nitzsch, in Denny, *Anoplur. Brit.*, p. 125, Pl. 6, f. 7; Pl. 11, f. 2 (1842).

Nirmus decipens (Nitz.) Piaget, *Pédiculines*, p. 180, Pl. 15, f. 4 (1880).

Waterston (1914) has recorded it taken off the type host, *Recurvirostra avosetta* (avocet), Philipstown, Cape Province. We have also taken it off *Crocethia alba* (sanderling), Swakopmund, South-West Africa (Tvl. Mus. No. 13538).

14. **Degeeriella emarginata** (Kellogg and Chapman).

Nirmus emarginatus Kell. & Chap., *Journ. New York Ent. Soc.*, X, p. 159 (1902).

Described from specimens taken off *Anous stolidus* (common noddy), a migrant to South Africa.

15. **Degeeriella erythropteri** (Piaget).

Nirmus erythropteri Piaget, *Pédicul.*, Suppl., p. 28, Pl. 3, f. 8 (1885).

Recorded by Bedford (1920) taken off little bee-eater, *Melittophagus pusillus meridionalis (= M. meridionalis)* and white-fronted bee-eater, *Coccolarynx bullockoides (= M. bullockoides)* in the Rustenburg District, Transvaal. They are, however, distinct species. The type, a male, was taken off *M. pusillus*.

16. **Degeeriella fulvofasciata** (Grube).

Nirmus fulvofasciatus Grube, *Mid. Sib. Reise*, p. 475, Pl. 31, f. 1 (1851).

Described from specimens taken off Terek sandpiper, *Terekia cinerea (= Tringa cinerea)*, a migrant to South Africa.

17. **Degeeriella furva** (Nitzsch).

Nirmus furvus Nitzsch, in Burmeister, *Handb.* II, p. 427 (1838).

Nirmus similis Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 374 (1866).

Nirmus naumanni Giebel, *Ins. Epiz.*, p. 163 (1874).

Nirmus furvus (Nitz.) Piaget, *Pédiculines*, p. 169, Pl. 14, f. 3 (1880).

Recorded by Piaget (1880) from the greenshank, *Glottis nebularius (= Totanus glottis)* and other birds. It has also been recorded from *Himantopus himantopus* (black-winged stilt) and great sandpiper, *Pagoa leschenaultii (= Charadrius geoffroyi)*.

18. **Degeeriella fusca** (Nitzsch).

Nirmus fuscus Nitzsch, in Denny, *Anoplur, Brit.*, p. 118, Pl. 9, f. 8 (1842).

Nirmus vittatus Giebel, *Ins. Epiz.*, p. 127 (1874).

Nirmus fuscus (Nitz.) Piaget, *Pédiculines*, p. 130, Pl. 10, f. 9 (1880).

Recorded from numerous accipitrines under different names, some of which will ultimately prove to be valid. It has been recorded taken from the following hosts in South Africa: By Waterston (1914) from *Pterolestes rufofuscus (= Buteo jakal), Nisaetus spilogaster (= Eutomaetus spilogaster), Hieraetus pennatus (= E. pennatus); Milierax musicus (= M. canorus)*, and *Pseudocircus macrourus (= Circus macrurus)*. By Bedford (1919, 1920, 1929) from *Aerospiza tachiro (= Astur tachiro), Elanus caeruleus, Tichornis naumanni (= Cerchneis naumanni), Micronisus gabar, Cuncuma vocifer (= Haliaetus vocifer), Pterolestes rufofuscus* and *Pteroaetus verreauxi*. It has also been recorded from the following South African birds in other countries: *Gyps rüppelli, Circus aeruginosus, Neonisus melanoleucus, Milvus aegyptius* and *Milvus migrans (= M. ater)*.

19. **Degeeriella gracilis** (Nitzsch).

Nirmus gracilis Nitzsch, in Burmeister, *Handb.* II, p. 429 (1838).

Nirmus elongatus Denny, *Anoplur. Brit.*, p. 140, Pl. 7, f. 4 (1842).

Nirmus gracilis (Nitz.) Piaget, *Pédiculines*, p. 15, Pl. 13, f. 10 (1880).

Described from specimens taken off house martin, *Chelidonaria urbica (= Delichon urbica)*. Waterston (1914) has also recorded it from *Hirundo rustica* (European swallow).

20. **Degeeriella gloriosa** (Kellogg and Kuwana).

Nirmus gloriosus Kell. & Kuw. *Proc. Wash. Acad. Sci.*, IV, p. 467, Pl. 29, f. 1 (1902).

Described from specimens taken off *Anous stolidus* (common noddy).

21. **Degeeriella hebes** (Kellogg).

Nirmus hebes Kellogg, *New Mallophaga*, I, p. 101, Pl. 5, f. 3 (1896).

Recorded taken off *Anous stolidus* (common noddy). The type host is *Sterna maxima*.

22. **Degeeriella hemichroa** (Nitzsch).

Nirmus hemichrous Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 372 (1866).

Described from specimens taken off *Himantopus himantopus* (black-winged stilt).

23. **Degeeriella hiaticulae** (Müller).

Pediculus hiaticulae Müller in Fabr., *Faun. Groen.*, p. 220 (1780).

Nirmus fissus Burmeister, *Hand.*, II, p. 427 (1838).

Nirmus bicuspis Giebel, *Ins. Epiz.*, p. 155, Pl. 5, f. 11, 12 (1874).

Nirmus bicuspis (Gie.) Piaget, *Pédiculines*, p. 184, Pl. 15, f. 7 (1880).

Described from specimens taken off *Charadrius hiaticula* (ringed plover). Piaget (1880) also recorded it from *Recurvirostra avosetta* (avocet). Both hosts are migrants to South Africa.

24. **Degeeriella holophaea** (Nitzsch).

Nirmus holophaeus Nitzsch, in Burmeister, *Handb.*, II, p. 427 (1838).

Nirmus holophaeus (Nitzsch) Piaget, *Pédiculines*, p. 171, Pl. 14, f. 4 (1880).

Specimens have been taken off the type host, the ruff, *Philomachus pugnax (= Machetes pugnax)* at Onderstepoort. Giebel (1874) also recorded it from the Knot, *Calidris canutus (= Tringa canuta)* and *Arenaria interpres* (turnstone), but the specimens were probably either stragglers or were incorrectly identified.

25. **Degeeriella hoplopteri** (Mjöberg).

Nirmus hoplopteri Mjöberg, *Arkir. f. Zool.*, VI, p. 157 (1910).

Recorded by Bedford (1919) taken off blacksmith plover, *Hoplopterus armatus (= H. speciosus)* at Bridgewater, Transvaal. It was described from specimens taken off *Hoplopterus spinosus* in the Sudan.

26. **Degeeriella hospes** (Nitzsch).

Nirmus hospes Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 371 (1866).

Described from specimens taken off grey plover, *Squatarola squatarola (= Vanellus squatarolus)*.

27. **Degeeriella hypoleuca** (Nitzsch).

Nirmus hypoleucus Nitzsch, in Denny, *Anoplur. Brit.*, p. 141, Pl. 6, f. 8 (1842).

Lipeurus hypoleucus (Nitz.) Piaget, *Pédiculines*, Suppl. p. 66, Pl. 7, f. 3 (1885).

Esthiopterum hypoleucum (Nitz.) Harrison, *Parasit.*, IX, p. 136 (1916).

A single male recorded by Bedford (1920) taken off the type host, *Caprimulgus europaeus* (European night-jar) in the Rustenburg District, Transvaal.

28. **Degeeriella kilimanjarensis** (Kellogg).

Nirmus kilimanjarensis Kellogg, *Schwed. Exp. Kilimanjaro*, p. 46, Pl 7, f. 3 (1910).

Described from specimens taken off Cape dabchick, *Podiocephalus capensis (= Colymbus capensis)* in East Africa.

29. **Degeeriella latirostris** (Burmeister).

Nirmus latirostris Burmeister, *Handb.*, II, p. 429 (1838).

Nirmus cuculi Denny, *Anoplur. Brit.*, p. 120, Pl. 10, f. 11 (1842).

Nirmus fenestratus Nitzsch, *Zeit. f. ges. Nat.*, XXVII, p. 117 (1866).

Nirmus fenestratus (Nitz.) Piaget, *Pédiculines*, p. 146, Pl.12, f. 3 (1880).

Described from specimens taken off *Cuculus canorus* (European cuckoo). It has also been taken off *Notococcyx solitarius* (red-chested cuckoo) at Pietermaritzburg, Natal (coll. L. Hill).

30. **Degeeriella leucocephala** (Nitzsch).

Nirmus leucocephalus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 365 (1866).

Described from specimens taken off white-necked raven, *Corvultur albicollis (= Corvus albicollis).*

31. **Degeeriella lingulata** (Waterson).

Nirmus lingulatus Waterston, *Ann. S. Afr. Mus.*, X, p. 286 (1914).

Described from numerous specimens taken off white-headed gull, *Bruchigavia novae-hollandiae hartlaubi (= Larus hartlaubi)* in Table Bay.

32. **Degeeriella macrocephala** (Waterson).

Nirmus macrocephalus Waterst. *Ann. S. Afr. Mus.*, X, p. 284, Pl. 25, f. 2, 5 (1914).

Described from numerous specimens taken off the following hosts in South Africa: White-fronted sandplover, *Leucopolius marginatus (Aegialitis marginatus)*; Kittlitz's sandplover, *L. pecuaria (= A. pecuaria)*, and three-banded sandplover, *Afroxechus tricollaris (= Aegialitis tricollaris).* Also recorded by Bedford (1920) from *L. marginatus,* Port Alfred, Cape Province.

33. **Degeeriella melanophrys** (Nitzsch).

Nirmus melanophrys Nitz., in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 369 (1866).

Docophorus upupae Denny, *Anoplur Brit.*, p. 92, Pl. 8, f. 1 (1842), *nec* Schrank, 1803.

Nirmus melanophrys Piaget, *Pédiculines*, p. 149, Pl. 12, f. 7 (1880).

Recorded by Waterston (1914) from *Upupa africana* (African hoopoe), Philipstown, Cape Province; also by Bedford (1919) taken from the same host at Pietermaritzburg, Natal. This species was described from specimens taken off *Upupa epops* (North African hoopoe).

34. **Degeeriella munda** (Nitzsch).

Nirmus mundus Nitzsch in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 366 (1866).

Described from specimens taken off European golden oriole, *Oriolus oriolus* (= *O. galbula*), a migrant to South Africa.

35. **Degeeriella nebulosa** (Burmeister).

Nirmus nebulosus Burmeister, *Hand.*, II, p. 429 (1838).

Nirmus nebulosus (Burm.) Piaget, *Pédiculines*, p. 155, Pl. 13, f. 4 (1880).

Recorded by Waterston (1914) taken off the type host, *Sturnus vulgaris* (European starling) in South Africa.

36. **Degeeriella normifer** (Grube).

Nirmus normifer, Grube, *Mid. Sib. Reise*, II, p. 478, Pl. 1, f. 8 (1851).

Nirmus triangulatus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVII, p. 378 (1866).

Nirmus triangulatus (Nitz.) Piaget, *Pédiculines*, p. 201, Pl. 16, f. 5 (1880).

Recorded by Piaget (1880) from the large white-necked skua, *Coprotheres pomarinus* (= *Lestris pomarina*). Also recorded by Kellogg (1908) from *Stercorarius parasiticus* (white-necked skua). The type host is *Lestris richardsoni* which does not occur in South Africa.

37. **Degeeriella numenii** (Denny).

Nirmus numenii Denny, *Anoplur. Brit.*, p. 144, Pl. 9, f. 6 (1842).

Described from specimens collected in England off *Numenius arquatus* (curlew) a migrant to South Africa.

38. **Degeeriella nycthemera** (Nitzsch).

Nirmus nycthemerus Nitzsch, in Burmeister, *Handb.*, II, p. 428 (1838).

Nirmus nycthemerus (Nitz.) Giebel, *Ins. Epiz.*, p. 174, Pl. 5, f. 8 (1874).

Described from specimens taken off little tern, *Sternula albifrons* (= *Sterna minuta*).

39. **Degeeriella obscura** (Burmeister).

Nirmus obscurus Burmeister, *Handb.*, II, p. 427 (1838).

Nirmus obscurus (Burm.) Giebel, *Ins. Epiz.*, p. 163, Pl. 6, f. 2, 3 (1874).

Described from specimens taken off wood sandpiper, *Rhyacophilus glareola* (= *Totanus glareola*). We have taken it off the same host at Onderstepoort.

40. **Degeeriella ochropi** (Denny).

Nirmus ochropi Denny, *Anoplur Brit.*, p. 134, Pl. 11, f. 12 (1842).

Described from specimens taken off green sandpiper, *Tringa erythropus (=Totanus ochropus)*, a migrant to South Africa.

41. **Degeeriella opisthotoma** (Kellogg).

Nirmus opisthotomus Kellogg, *Schwed. Exp. Kilimanjaro*, p. 46, Pl. 7, f. 4 (1910).

Described from specimens taken off *Himantopus himantopus* (black-winged stilt) in East Africa.

42. **Degeeriella phaeopi** (Denny).

Nirmus phaeopi Denny, *Anoplur. Brit.*, *p.* 144, Pl. 10, f. 7 (1842).

Nirmus phaeopodis Giebel, *Ins. Epiz.*, p. 166 (1874).

Nirmus inaequalis Piaget, *Pédiculines*, p. 176, Pl. 15, f. 1 (1880).

Described by Denny from specimens taken off whimbrel, *Phaeopus phaeopus (= Numenius phaeopus)*, and by Piaget from *Numenius arquatus* (curlew). Both hosts are migrants to South Africa.

43. **Degeeriella phlyctopyga** (Nitzsch).

Nirmus phlyctopygus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XVII, p. 526 (1861).

Nirmus phlyctopygus (Nitz.) Giebel, *Ins. Epiz.*, p. 128 (1874).

Described from specimens taken off *Pernis apivorus* (honey buzzard), a migrant.

44. **Degeeriella quadrangularis** (Rudow).

Nirmus quadrangularis Rudow, *Beitrag.*, p. 18 (1869).

Described from specimens taken off pied crow, *Corvus albus (= Corvus scapulatus)*.

45. **Degeeriella quadrisetacea** (Piaget).

Nirmus quadrisetaceus Piaget, *Pédiculines*, p. 668, Pl. 55, f. 5 (1880).

Described from specimens taken off the painted snipe, *Rostratula benghalensis (= Rhynchaea variegata)*. Specimens have been taken off the same host in the Rustenburg District, Transvaal (coll. W. Powell).

46. **Degeeriella rufa** (Nitzsch).

Nirmus rufus Nitzsch, in Burmeister, *Handb.*, II, p. 430 (1838).

Nirmus rufus (Nitz.) Piaget, *Pédiculines*, p. 131 (1880).

This species has been recorded by both Piaget (1880) and Mjöberg (1910) from *Falco subbuteo* (hobby), a migrant. Specimens have also been taken off *Melanocircus maurus* (black (harrier), Stellenbosch, C.P.

47. **Degeeriella sacra** (Giebel).

Nirmus sacer Giebel, *Zeit. f. ges.* Nat., XXVIII, p. 375 (1866).

Nirmus sacer Giebel, *Ins. Epiz.*, p. 171 (1874).

Described from specimens taken off glossy ibis, *Plegadis falcinellus* (= *Ibis sacra*), a migrant from Europe.

48. **Degeeriella scalaris** (Piaget).

Nirmus scalaris Piaget, *Pédiculines*, p. 190, Pl. 17, f. 2 (1880).

Described from specimens taken off the ruff, *Philomachus pugnax* (= *Machetes pugnax*). Specimens have been taken off the same host at Onderstepoort (G.A.H.B.).

49. **Degeeriella scolopacis** (Denny).

Nirmus scolopacis Denny, *Anoplur. Brit.*, p. 149, Pl. 11, f. 8 (1842).

Nirmus truncatus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 375 (1866).

Nirmus tristis Giebel, *Ins. Epiz.*, p. 168 (1874).

Nirmus truncatus (Nitz.) Piaget, *Pédiculines*, p. 178, Pl. 15, f. 2 (1880).

Specimens have been taken off *Capella nigripennis* (Ethiopean snipe) at Onderstepoort (G.A.H.B.). It was described by Denny and others from specimens taken off *Scolopax gallinago* (European snipe).

50. **Degeeriella sellata** (Burmeister).

Nirmus sellatus Burmeister, *Handb.*, II, p. 428 (1838).

Nirmus selliger Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 376 (1866).

Nirmus selliger (Nitz.) Piaget, *Pédiculines*, p. 197, Pl. 16, f. 2 (1880).

Piaget (1880) has recorded this species taken from *Sterna hirundo* (common tern) and the sandwich tern, *Thalasseus sandvicensis* (= *Sterna cantiaca*) in the Zoological Gardens at Rotterdam. Both birds are migrants to South Africa.

51. **Degeeriella signata** (Piaget).

Nirmus signatus Piaget, *Pédiculines*, p. 186, Pl. 15, f. 8 (1880).

Described from specimens taken off *Recurvirostra avosetta* (avocet) in the Zoological Gardens at Rotterdam. Waterston (1914) has recorded it taken off the same host in South Africa.

52. **Degeeriella stictochroa** (Nitzsch).

Nirmus stictochrous Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 374 (1866).

Nirmus stictochrous (Nitz.) Piaget, *Pédiculines*, p. 193 (1880).

Described from specimens taken off *Dromas ardeola* (crab plover), a migrant.

53. **Degeeriella strepsilaris** (Denny).

Nirmus strepsilaris Denny, *Anoplur. Brit.*, p. 135, Pl. 11, f. 4 (1842).

Nirmus subcingulatus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 372 (1866).

Described by both Denny and Giebel from specimens taken off turnstone, *Arenaria interpres (= Strepsilas interpres)*, a migrant to South Africa.

54. **Degeeriella subcuspidata** (Nitzsch).

Nirmus subcuspidatus Nitzsch, in Burmeister, *Handb.*, II, p. 430 (1838).

Nirmus subcuspidatus Piaget, *Pédiculines*, p. 148, Pl. 12, f. 5 (1880).

Ferris (1916) has recorded it taken off the type host, *Coracias garrulus* (European roller) in South Africa.

55. **Degeeriella tenuis** (Nitzsch).

Nirmus tenuis Nitzsch, in Burmeister, *Handb.*, II, p. 430 (1838).

Nirmus tenuis (Nitz.) Denny, *Anoplur Brit.*, p. 148, Pl. 11, f. 9 (1842).

Described by both Burmeister and Denny from specimens taken off European sandmartin, *Riparia riparia (= Hirundo riparia)*, a migrant.

56. **Degeeriella testudinaria** (Children).

Nirmus testudinarius Child., *App. Back's Land Exp.*, p. 538 (1836).

Nirmus biseriata Child., *ibid.*, p. 538 (1836).

Nirmus pileus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVII, p. 373 (1866).

Nirmus pileus Piaget, Pédiculines, p. 182, Pl. 15, f. 6 (1880).

Recorded by Waterston (1914) taken off *Recurvirostra avosetta* (avocet), Philipstown, C.P. We have also taken it off *Crocethia alba* (sanderling), Swakopmund, South-West Africa (Tvl. Mus. No. 13538). It was described by Children from specimens taken of *R. americana* and by Giebel and Piaget from *R. avosetta*.

57. **Degeeriella umbrina** (Nitzsch).

Nirmus umbrinus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 371 (1866).

Nirmus umbrinus (Nitz.) Giebel, *Ins. Epiz.*, p. 171 (1874).

Recorded by Bedford (1919) taken off hammerhead, *Scopus umbretta bannermani (= S. umbretta)* in the Rustenburg District, Transvaal, and at Pietermaritzburg, Natal. The type was taken off *S. umbretta*.

58. **Degeeriella varia** (Nitzsch).

Nirmus varius Nitzsch, in Burmeister, *Handb.*, II, p. 430 (1838).

Nirmus varius (Nitz.) Piaget, *Pédiculines*, p. 139, Pl. 11, f. 8 (1880).

Nirmus varius (Nitz.) Kell. & Paine, *Bull. Ent. Res.*, II, p. 147, Pl. 5, f. 5, 5a (1911).

Recorded by Waterston (1914) taken off black crow, *Heterocorax capensis (= Corvus capensis)* in South Africa. Also recorded by Bedford (1920) from the same host under the name of *D. argula* (Nitzsch). Kellogg and Paine (1911) recorded it from *Corvultur albicollis* (white-necked raven) in Southern Nigeria.

59. **Degeeriella vulgata** (Kellogg).

Nirmus vulgatus Kellogg, *New Mallophaga*, II, p. 496, Pl. 57, f. 5 (1896).

Recorded by Waterston (1914) taken off Cape sparrow, *Passer melanurus (= P. arcuatus)* at Capetown, C.P.; also from *Amadina erythrocephala* (red-headed finch) at Philipstown, C.P. It was described by Kellogg from a number of Passeriformes in the United States.

60. **Degeeriella zonaria** (Nitzsch).

Nirmus zonarius Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 374 (1866).

Nirmus zonarius (Nitz.) Giebel, *Ins. Epiz.*, p. 166 (1874).

Recorded by Waterston (1914) and Bedford (1920) taken off curlew sandpiper, *Erolia testacea (= Tringa subarquata)* in South Africa; also by the latter from one of the type hosts, the little stint, *Pisobia minuta (= Tringa minuta)* in the Pretoria District.

Genus Goniodes Nitzsch.

Goniodes Nitzsch, *Germar's Magazin*, III, p. 293 (1818).

This genus contains about sixty species found on Galliformes, Columbiformes and South American tinamous.

Genotype: *Pediculus pavonis* Linné.

1. **Goniodes aegypticus** (Kellogg and Paine).

Goniodes minor Piaget, *Pédiculines*, p. 256, Pl. 21, f. 3 (1880). *nec* Piaget, p. 248. 1880.

Goniocotes aegypticus Kellogg & Paine, *Bull. Ent. Res.*, II, ii, p. 148, Pl. 5, f. 2 (1911).

Goniodes piageti Johnston & Harrison, *Proc. Roy. Soc. Qsld.*, XXIV, p. 19 (1912).

Waterston (1914) recorded this species from South Africa taken off *Vinago delalandi* (Cape green pigeon) and Cape turtle dove, *Afropelia capicola (= Turtur capicola)*. Bedford (1920)

recorded it taken off *A. capicola damarensis* (Damara turtle dove) and laughing dove, *Stigmatopelia senegalensis (= Turtur senegalensis)* in the Transvaal. A ♀ has also been taken off *Dialiptila phaeonota* (Cape rock pigeon), Ugab River, South-West Africa (coll. R. D. Bradfield).

2. **Goniodes assimilis** Paiget.

Goniodes assimilis Piaget, *Pédiculines*, p. 248 (1880).

Described from specimens taken off Cape noisy francolin, *Chaetopus capensis (= Francolinus capensis)* in the Zoological Gardens at Rotterdam.

3. **Goniodes dissimilis** Nitzsch.

Goniodes dissimilis, Nitzsch, in Denny, *Anoplur. Brit.*, p. 162, Pl. 12, f. 6 (1842).

Goniodes dissimilis (Nitz.) Piaget, *Pédiculines*, p. 268, Pl. 22, f. 3 (1880).

Specimens have been taken off domestic fowls at Pietermaritzburg, Natal (coll. L. Hill).

4. **Goniodes fimbriatus** Neumann.

Goniodes fimbriatus Neu., *Arch. Parasit.*, XV, p. 629, f. 19, 20 (1913).

Described from specimens taken off unknown hosts at Konakry and Mocambique.

5. **Goniodes hilli** Bedford.

Goniodes hilli Bedf., *Rep. Dir. Vet. Res.*, Un. S. Afr., VII & VIII, p. 724, Pl. 5, f. 3 (1920).

Described from specimens taken off red-eyed turtle dove, *Streptopelia semitorquata (= Turtur semitorquatus)* at Pietermaritzburg, Natal.

6. **Goniodes meliagridis** (Linnaeus).

Pediculus meleagridis Linné, *Syst. Nat.*, p. 613 (1758).

Goniodes stylifer Nitzsch, in Burmeister, *Handb.*, II, p. 432 (1838).

Goniodes stylifer (Nitz.) Piaget, *Pédiculines*, p. 264, Pl. 22, f. 1 (1880).

Goniodes styliferum Taschenberg, *Die Mallophagen*, p. 47 (1882).

A common parasite on the domestic turkey in South Africa.

7. **Goniodes numidae** Mjöberg.

Goniodes numidae Mjöberg, *Arkiv. f. Zool.*, VI, p. 103, f. 60, 61 (1910).

Described from specimens taken off *Numida ptilorhyncha* in the Sudan. Bedford (1919) has recorded it from *Numida coronata*, Bridgewater, Transvaal, but the skin is in the Transvaal Museum and proves to be *N. papillosa transvaalensis.* Also recorded by Bedford (1929) from *N. papillosa*, Kunene River, South-West Africa.

8. **Coniodes parviceps** Piaget.

Goniodes parviceps Piaget, *Pédiculines*, p. 277, Pl. 23, f. 2 (1880).

A parasite of *Paro cristatus*, but not yet recorded from this bird in South Africa.

9. **Coniodes pavonis** (Linnaeus).

Pediculus pavonis Linné, *Syst. Nat.*, p. 613 (1758).

Goniodes falcicornis Nitzsch, in Burmeister, *Handb.*, II, p. 432 (1838).

Goniodes falcicornis (Nitz.) Piaget, *Pédiculines*, p. 275, Pl. 23, f. 1 (1880).

Recorded by Waterston (1914) taken from *Paro cristatus* in South Africa.

10. **Coniodes pternistis** Bedford.

Goniodes pternistis Bedf., *Ann. Rep. Dir. Vet. Serv.*, Un. S. Afr., XV, p. 520, f. 21 (1929).

Described from specimens taken off *Pternistis swainsoni* (Swainson's red-necked francolin) in the Zoological Gardens, Pretoria.

11. **Coniodes scleroptilus** Bedford.

Goniodes scleroptilus Bedf., *Ann. Rep. Dir. Vet. Serv.*, Un. S. Afr., XV, p. 520, f. 20 (1929).

Described from specimens taken off *Scleroptila gariepensis pallidior* (Ovambo partridge)*, Kunene River, South-West Africa.

Genus GONIOCOTES Burmeister.

Goniocotes Burmeister, *Handb. der Ent.* II, p. 431 (1838).

This genus contains about fifty species found on Galliformes, Columbiformes and South American tinamous.

Genotype: *Goniocotes hologaster* Nitzsch.

1. **Goniocotes bidentatus** (Scopoli).

Pediculus bidentatus Scopoli, *Ent. Carn.*, p. 285 (1763).

Goniocotes compar Nitzsch in Burmeister, *Handb.*, II, p. 431 (1838).

Goniocotes compar (Nitz.) Piaget, *Pédiculines*, p. 234, Pl. 19, f. 10 (1880).

Recorded by Bedford (1919) taken off domestic pigeons at Onderstepoort, Transvaal, and Pietermaritzburg, Natal.

2. **Goniocotes hologaster** Nitzsch.

Goniocotes hologaster Nitzsch, in Burmeister, *Handb.*, II, p. 431 (1838).

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* Mr. Roberts has examined the skin and informs me that it is *Scleroptila jugularis*.

Goniocotes hologaster var. maculatus Taschenberg, *Die Mallophagen*, p. 76, Pl. 3, f. 3 (1882).

Goniocotes nigromaculatus Mjöberg, *Arkiv. f. Zool.*, VI, p. 106, f. 62 (1910).

Goniocotes nigromaculatus (Mjöb.) Bedf., *Rep. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 726, Pl. 5, f. 4 (1920).

Recorded by Bedford (1920) from domestic fowl, Pretoria North; bush partridge, *Dendroperdix sephaena (= Francolinus sephaena)* and *Numida coronata* in the Transvaal. The skin of the last-named bird is in the Transvaal Museum and proves to be *N. papillosa transvaalensis.* Also recorded by Bedford (1929) from *N. papillosa*, Kunene River, South-West Africa. One ♀ taken off *Pternistis castaneiventer krebsi* (Drakensberg red-necked francolin), Zoo, Pretoria.

3. **Goniocotes gigas** Taschenberg.

Goniocotes hologaster Denny, *Anoplur. Brit.*, p. 153, Pl. 12, f. 4 (1842), *nec* Nitzsch, 1838.

Goniocotes gigas Taschenberg, *Zeit. f. ges. Nat.*, LII, p. 104, Pl. 1, f. 10 (1879).

Goniocotes abdominalis Piaget, *Pédiculines*, p. 238, Pl. 20, f. 9 (1880).

Recorded by Bedford (1919) from domestic fowls at Onderstepoort and at Pietermaritzburg, Natal; also from *Numida coronata*, Bridgewater, Transvaal, the host proving to be *N. papillosa transvaalensis.* Also recorded by Bedford (1929) from *N. papillosa*, Kunene River, South-West Africa.

4. **Goniocotes rectangulatus** Nitzsch.

Goniocotes rectangulatus Nitzsch, in Giebel, *Zeit. f. ges. Nat.* XXVIII, p. 389 (1866).

Goniocotes rectangulatus (Nitz.) Piaget, *Pédiculines*, p. 230, Pl. 19, f. 5 (1880).

A parasite of *Pavo cristatus*, but not yet recorded from this bird in South Africa.

Genus Austrogoniodes Harrison.

Austrogoniodes Harrison, *Parasit.*, VII, p. 398 (1915).

This genus includes four species found on *Spheniscidae*. They were formerly placed in the genera *Goniodes* and *Goniocotes*.

1. **Austrogoniodes bifasciatus** (Piaget).

Goniocotes bifasciatus Piaget, *Pédiculines*, Suppl., p. 47, Pl. 5, f. 6 (1885).

Recorded by Waterston (1914) taken off the type host, *Spheniscus demersus* (jackass penguin) in South Africa.

Genus ACIDOPROCTUS Piaget.

Acidoproctus Piaget, *Tijd. v. Ent.*, XXI, p. 178 (1878).

Akidoproctus Piaget, *Pédiculines*, p. 208 (1880).

This genus includes five species found on Anatidae.

Genotype: *Acidoproctus marginatus* Piaget.

1. **Acidoproctus marginatus** Piaget.

Acidoproctus marginatus Piaget, *Tijd. v. Ent.*, XXI, p. 179, Pl. 12, fig. e (1878).

Acidoproctus bifasciatus Piaget, *ibid.*, XXI, p. 181, Pl. 12, fig. G (1878).

Akidoproctus marginatus Piaget, *Pédiculines*, p. 209, Pl. 17, f. 4 (1880).

Akidoproctus bifasciatus Piaget, *ibid.*, p. 210, Pl. 17, f. 5 (1880).

It is unfortunate that *marginatus* has priority over *bifasciatus* as it was described from an immature specimen, a straggler found on a gull, *Larus spinicauda.* This name is not mentioned by J. Dwight in his monograph "The Gulls (Laridae) of the World" *(Bull. Amer. Mus. Nat. Hist.*, LII, iii, pp. 63-401, (1925). *A. bifasciatus* was also described from a straggler—a ♀ found on *Dromas ardeola.* Recorded by Bedford (1919) taken off the following hosts in the Rustenburg District, Transvaal: *Dendrocygna viduata* (white-faced duck); *Sarkidiornis melanotus* (knob-billed duck); *Casarca cana* (South African sheldrake); red-billed duck, *Paecilonitta erythrorhyncha (= Anas erythrorhyncha); Thalassornis leuconotus* (white-backed duck) and *Plectropterus gambensis* (spur-winged goose).

2. **Acidoproctus rostratus** (Rudow).

Ornithobius rostratus Rudow, *Beitrag z. Kenntn. d. Malloph.*, p. 46 (1869).

Nirmus stenopygos Nitzsch, in Giebel, *Ins. Epiz.*, p. 179, Pl. 8, f. 6, 7 (1874).

Akidoproctus stenopygus (Nitz.) Kellogg & Paine, *Bull. Ent. Res.*, II, p. 148, Pl. 5, f. 6, 6a, b (1911).

Described by Rudow from immature specimen taken off *Alopochen aegyptiacus*, and by Giebel from *Anas rufina.* Recorded by Kellogg and Paine (1911) taken off *Plectropterus gambensis* (spur-winged goose) in the Sudan, and by Bedford (1919 and 1929) from the same host in the Rustenburg District, Transvaal, and from *A. aegyptiacus*, Tamanzu, South-West Africa.

Genus HARRISONIELLA Bedford.

Harrisoniella Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 529 (1929).

This genus includes a single species.

1. **Harrisoniella diomedea** (Fabricius).

Pediculus diomedeae Fabr., *Syst. Ent.*, p. 808 (1775).

Lipeurus ferox Giebel, *Zeit. f. ges. Nat.*, XXIX, p. 195 (1867).

L. ferox (Gie.) Taschenberg, *Nova Acta*, XLIV, p. 145, Pl. 5, f. 1, 1a (1882).

L. ferox (Gie.) Kellogg, *New Mallophaga*, I, p. 127, Pl. 9, f. 1, 2 (1896).

L. densus (Gie.) Kellogg, *ibid.*, p. 114, Pl. 7, f. 1, 2 (1896).

Recorded by Waterston (1914) taken off *Diomedea exulans* (wandering albatross) in South Africa; also by Bedford (1929) from the type host, *Thalassarche melanophrys* (mollymawk), Capetown, C.P.

Genus Pseudonirmus Mjöberg.

Pseudonirmus Mjöberg, *Arkiv. f. Zool.*, VI, p. 149 (1910).

This genus includes two species found on Hydrobatidae.

Genotype: *Degeeriella charcoti* Neumann.

1. **Pseudonirmus gurlti** (Taschenberg).

Lipeurus gurlti (Taschenberg) *Nova Acta*, XLIV, p. 151, Pl. 5, f. 6 (1882).

Lipeurus lugubris Taschenb. *ibid.*, XLIV, p. 153, Pl. 6, f. 9 (1882).

Recorded by Bedford (p. 528, 1929) taken off the type host, *Daption capensis* (Cape sea-pigeon) at Capetown.

Genus Naubates Bedford.

Naubates Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVI, p. 167 (1930).

This genus contains three species found on Hydrobatidae and Diomedeidae.

Genotype: *Lipeurus fuliginosus* Taschenberg.

1. **Naubates fuliginosus** (Taschenberg).

Lipeurus fuliginosus Taschenb., *Nova Acta.*, XLIV, p. 156, Pl. 4, f. 3 (1882).

Lipeurus testaceus Taschenb., *ibid.*, p. 135, Pl. 5, f. 3 (1882).

Naubates fuliginosus (Tasch.) Bedf., *Rep. Dir. Vet. Serv. & Anim. Indust.*, XVI, p. 168, f. 9, 11, 15, 16a (1930).

Type hosts of *fuliginosus*: *Diomedea exulans* (wandering albatross) and *Nealbatrus chlororhynchus* (yellow-billed mollyhawk); *testaceus*: Cape sea-pigeon, *Daption capensis* (= *Procellaria capensis*). Waterston (1914) has recorded it from the following hosts in South Africa: *D. exulans*; mollymawk, *Thalassarche melanophrys* (= *D. melanophrys*); *Oceanites oceanicus* (sooty petrel), and *Procellaria aequinoctialis* (Cape hen). Kellogg (1914) has also recorded it from the following

hosts in the South Atlantic: giant petrel, *Macronectes giganteus* (= *Ossifraga gigantea*); great grey petrel, *Adamastor cinerea* (= *Priofinus cinereus*); soft-plumaged petrel, *Pterodroma mollis* (= *Oestrelata mollis*); brown petrel, *P. incerta* (= *O. incerta*), and *Sterna paradisea* (arctic tern). Its occurrence on the last-named host was due to straggling.

2. **Naubates harrisoni** Bedford

N. harrisoni Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust.*, XVI, p. 168, f. 12, 14, 16b (1930).

Described from ♂♂ and a ♀ taken off *Ardenna gravis* (great shearwater) at Capetown, C.P.

3. **Naubates pterodromi** Bedford.

N. pterodromi Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust.*, XVI, p. 170, f. 10, 13 (1930).

Described from ♀♀ taken off *Pterodroma macroptera* (Cape parson) at Capetown, C.P.

Genus Pectinopygus Mjöberg.

Pectinopygus Möjberg, *Arkir. f. Zool.*, VI, p. 95 (1910).

This genus includes several species found on birds belonging to the families Phalacrocoracidae, Anhingidae, Sulidae, Fregatidae, Phaetontidae and Pelecanidae.

Genotype: *Pediculus bassanae* O. Fabricius.

1. **Pectinopygus acutifrons** (Rudow).

Lipeurus acutifrons Rudow, *Zeit. f. ges. Nat.*, XXXV, p. 138 (1870).

Nirmus capensis Rudow, ibid., p. 469 (1870).

Nirmus dispar Piaget, *Pédiculines*, p. 174, Pl. 14, f. 7 (1880).

Waterston (1914) has recorded it taken off the type host, Cape cormorant, *Pseudocarbo capensis* (= *Phalacrocorax capensis*) in Table Bay. Specimens have also been taken off *Anacarbo neglecta* (bank cormorant), Dyers Island, C.P.

2. **Pectinopygus afer** (Kellogg).

Lipeurus afer Kellogg, *Schwed. Zool. Exp. Kilimanjaro*, p. 47, Pl. 7, f. 5 (1910).

Described from specimens taken off reed cormorant, *Microcarbo africana* (= *Phalacrocorax africanus*) in East Africa. Waterston (1914) has recorded it taken from the same host in Table Bay. Specimens have also been taken off *Microcarbo coronata* (crowned cormorant), Swakopmund, South-West Africa (coll. R. D. Bradfield).

3. **Pectinopygus bassanae** (O. Fabricius).

Pediculus bassanae O. Fabr., *Faun. Groen.*, p. 218 (1780).

Lipeurus staphylinoides Denny, *Anoplur. Brit.*, p. 180, Pl. 15, f. 2 (1842).

Lipeurus pullatus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 387 (1866).

Lipeurus pullatus (Nitz.) Piaget, *Pédiculines*, p. 339, Pl. 27, f. 9 (1880).

Lipeurus pullatus (Nitz.) Cummings, *Proc. Zool. Soc. Lond.*, p. 691, f. 36 (1916).

Type host: *Sula bassanae* Linné (European gannet). Recorded by Waterston (1914) from malagash, *Sulita capensis* (= *Sula capensis*), Capetown, C.P., but it is probably a distinct species.

4. **Pectinopygus forficulatus** (Nitzsch).

Lipeurus forficulatus Nitzsch, *Zeit. f. ges. Nat.*, XXVIII, p. 386 (1866).

Lipeurus forficulatus (Nitz.) Taschenb., *Nova Acta.*, p. 156, Pl. 4, f. 3 (1882).

Lipeurus forficulatus (Nitz.) Cummings, *Proc. Zool. Soc. Lond.*, p. 682, f. 27-35 (1916).

Recorded by Giebel (1874) and Taschenberg (1882) from *Pelecanus onocrotalus* (European pelican). Also recorded by Bedford (1919) taken off pink-backed pelican, *Neopelecanus rufescens* (= *Pelecanus rufescens*) in the Zoological Gardens, Pretoria.

5. **Pectinopygus gracilicornis** (Piaget).

Lipeurus gracilicornis Piaget, *Pédiculines*, p. 309, Pl. 25, f. 6 (1880).

Described from specimens taken off *Fregata minor* (frigate bird).

6. **Pectinopygus longicornis** (Piaget).

Lipeurus longicornis Piaget, *Pédiculines*, p. 334, Pl. 27, f. 3 (1880).

Type hosts: *Phalacrocorax carbo* and *P. cristatus*. Recorded by Waterston (1914) and Bedford (1920) taken off *Phalacrocorax lucidus* in South Africa.

7. **Pectinopygus majus** (Kellogg) 1899 *nec* Piaget, 1880.

Lipeurus gracilicornis var. majus Kell., *New Mallophaga*, III, p. 30 (1899).

Type host: *Fregata aquila*. Recorded by Kellogg (1914) taken off *Fregata ariel* and tropic bird, *Leptophaeton lepturus* (= *Phaethon lepturus*) in the South Atlantic. The latter species occurs on the South African coast, but the occurrence of this parasite on this host is probably due to straggling.

8. **Pectinopygus setosus** (Piaget).

Lipeurus setosus Piaget, *Pédiculines*, p. 335, Pl. 27, f. 4 (1880).

Type host: *Phalacrocorax sulcirostris*. Recorded by Paiget (1885) taken off reed cormorant, *Microcarbo africana* (= *Graculus africanus*) and Cape snake-bird, *Anhinga rufa levaillanti* (= *Plotus levaillantii*) in the Leyden Museum.

Genus Esthiopterum Harrison.

Esthiopterum Harrison, *Parasit.*, IX, p. 129 (1916).

This genus includes nearly two hundred and fifty species formerly placed in the genus *Lipeurus*.

Genotype: *Pediculus gruis Linné.*

1. **Esthiopterum angusticeps** (Piaget).

Lipeurus angusticeps Piaget, *Pédiculines*, p. 306, Pl. 25, f. 4 (1880).

Described from specimens taken off great grey petrel, *Adamastor cinereus (= Procellaria cinerea)* in the Leyden Museum.

2. **Esthipoterum anseris** (Linnaeus).

Pediculus anseris Linné, *Syst. Nat.*, p. 612 (1758).

Lipeurus jejunus Nitzsch, in Denny, *Anoplur. Brit.*, p. 177, Pl. 15, f. 4 (1842).

Lipeurus jejunus Piaget, *Pédiculines*, p. 348, Pl. 30, f. 8 (1880).

Recorded by Bedford (1919) taken off domestic goose at Pietermaritzburg, Natal. Piaget (1880) recorded it from several geese, including the Egyptian goose, *Alopochen aegyptiacus (= Anser aegyptiacus).*

3. **Esthiopterum ardeae** (Linnaeus).

Pediculus ardeae Linné, *Syst. Nat.*, p. 613 (1758).

Lipeurus leucopygus Nitzsch, in Burmeister, *Handb.*, II, p. 434 (1838).

Lipeurus leucopygus (Nitz.) Piaget, *Pédiculines*, p. 318, Pl. 6, f. 4 (1880).

Recorded by Bedford (1919) taken off the type host, *Ardea cinerea* (grey heron) in the Rustenburg District, Transvaal.

4. **Esthiopterum asymmetricum** (Rudow).

Lipeurus asymmetricus Rudow, *Zeit. f. ges. Nat.*, XXXV, p. 132 (1870).

Lipeurus gambensis Piaget, *Pédiculines, Suppl.*, p. 64, Pl. 7, f. 1 (1885).

Described by Rudow from specimens taken off Egyptian goose, *Alopochen aegyptiacus (= Anser aegyptiacus)*, and by Piaget from specimens taken off *Plectropterus gambensis* (spur-winged goose). Bedford (1919 and 1929) has recorded it taken off the former host in South-West Africa, and off the latter host in the Rustenburg District, Transvaal.

5. **Esthiopterum capitatum** (Piaget).

Lipeurus capitatus Piaget, *Pédiculines, Suppl.*, p. 63, Pl. 6, f. 9 (1885).

Recorded by Kellogg and Ferris (1915) and Bedford (1919) taken off the type host, *Hagedashia hagedash* (hadada ibis) at Mfongosi, Zululand.

6. **Esthiopterum ciconiae** (Linnaeus).

Pediculus ciconiae Linné, *Syst. Nat.*, p. 613 (1758).

Lipeurus versicolor Nitzsch, in Burmeister, *Handb.*, II, p. 434 (1838).

Lipeurus maculatus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 383 (1866).

Lipeurus fissomaculatus Giebel, *Ins. Epiz.*, p. 225 (1874).

Lipeurus versicolor (Nitz.) Piaget, *Pédiculines*, p. 315, Pl. 27, f. 2 (1880).

Lipeurus variegatus Neumann, *Arch. Parasit.*, XV, p. 381, f. 27, 28 (1912).

Recorded by Waterston (1914) taken off the type host—white stork, *Ciconia ciconia (= C. alba).* It was described by Giebel in 1866 from black stork, *Melanopelargus niger (= Ciconia nigra)*, and in 1874 from marabou stork, *Leptoptilus crumeniferus (= Mycteria crumenifera).*

7. **Esthiopterum crassicorne** (Scopoli).

Pediculus crassicornis Scopoli, *Ent. Carn.*, p. 383 (1763).

Lipeurus squalidus Nitzsch in Denny, *Anoplur. Brit.*, p. 176, Pl. 14, f. 5 (1842).

Lipeurus squalidus (Nitz.) Piaget, *Pédiculines*, p. 344, Pl. 30, f. 5 (1880).

Piaget (1880) has recorded this species from several ducks, including *Anas domestica* and European shoveller, *Spatula clypeata (= Anas clypeata).* Bedford (1919) has recorded it from *Paecilonitta erythrorhyncha* (red-billed teal) in the Rustenburg District, Transvaal. Specimens have also been taken off *Nototnetta capensis* (Cape wigeon), Swakopmund, S.W.A. (coll. R. D. Bradfield).

8. **Esthiopterum diversum** (Kellogg).

Lipeurus diversus Kellogg, *New Mallophaga*, I, p. 123, Pl. 8, f. 3, 4 (1896).

Lipeurus limitatus Kellogg, *ibid.*, p. 124, Pl. 9, f. 5, 6 (1896).

Type host of *diversus: Puffinus opisthomelas.*

Recorded by Waterston (1914) taken off Cape hen, *Procellaria aequinoctialis (= Majaqueus aequinoctialis)* and *Oceanites oceanicus* (sooty petrel) in South Africa. Kellogg (1914) recorded specimens taken off the following hosts in the South Atlantic; great grey petrel, *Adamastor cinereus (= Priofinus cinereus);* brown petrel, *Pterodroma incerta (= Oestrelata incerta);* soft plumed petrel, *Pterodroma mollis (= Oestrelata mollis)*; mollymawk, *Thalassarche melanophrys (= Diomedea melanophrys);* arctic tern, *Sterna macrura (= S. paradisea)* and *Puffinus anglorum.* All these hosts occur on the South African coast, except the last named.

9. **Esthiopterum emarginatum** (Piaget).

Lipeurus emarginatus Piaget, *Pédiculines*, p. 328, Pl. 28, f. 2 (1880).

Described from a male taken off green sandpiper, *Tringa erythropus (= Totanus ochropus)*, a migrant from Europe.

10. **Esthiopterum genitale** (Piaget).

Lipeurus genitalis Piaget, *Pédiculines*, Suppl., p. 58, Pl. 6, f. 5 (1885).

Described from specimens taken off *Leptoptilus crumeniferus* (marabou stork).

11. **Esthiopterum giganticola** (Kellogg).

Nirmus giganticola Kellogg, *New Mallophaga*, I, p. 105, Pl. 5, f. 6 (1896).

Lipeurus confidens Kellogg, *ibid.*, III, p. 26, Pl. 3, f. 1 (1899).

Lipeurus miriceps Kell. & Kuw., *Proc. Wash. Acad. Sci.*, IV, p. 480 (1902).

Type host of *giganticola: Diomedea albatrus;* of *confidens: D. nigripes;* of *miriceps: D. sp.* Recorded taken in South Africa by Waterston (1914) and Bedford (1920) off Layard's albatross, *Diomedella cauta layardi (= Thalassogeron layardi)*; also by Waterston (1914) off wandering albatross *(Diomedea exulans)*; mollymawk, *Thalassarche melanophrys (= D. melanophrys)*, and yellow-billed mollymawk *(Nealbatrus chlororhynchus)*.

12. **Esthiopterum lepidum** (Nitzsch).

Lipeurus lepidus Nitzsch. in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 383 (1866).

Lipeurus signatus Piaget, *Pédiculines*, p. 310, Pl. 25, f. 7 (1880).

Type host: *Anastromus coromanelicus.* Piaget described it from specimens taken off *Anastromus lamelligerus* (open-bill stork).

13. **Esthiopterum leucoproctum** (Nitzsch).

Lipeurus leucoproctus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 384 (1866).

Lipeurus leucopygus var. minor Piaget, *Pédiculines*, p. 320 (1880).

Described from specimens taken off purple heron, *Pyrrherodia purpurea (= Ardea purpurea)*.

14. **Esthiopterum modestum** (Giebel).

Lipeurus modestus Giebel, *Ins. Epiz.*, p. 210 (1874).

Lipeurus grandis Piaget, *Pédiculines*, p. 323, Pl. 26, f. 7 (1880).

Lipeurus loculatus Kell. & Chap., *New Mallophaga*, iii, p. 93, Pl. 7, f. 1 (1899).

Described by Giebel from specimens taken off the large white-necked skua, *Coprotheres pomarinus (= Lestris pomarina).* Kellogg (1914) recorded specimens taken off the southern skua, *Catharacta skua antarticus (= Megalestris antartica)* in the South Tropical Atlantic.

15. **Esthiopterum nigrolimbatum** (Giebel).

Lipeurus nigrolimbatus Giebel, *Ins. Epiz.*, p. 233 (1874).

Lipeurus mutabilis Piaget, *Pédiculines*, p. 324, Pl. 27, f. 1 (1880).

Lipeurus celer Kellogg, *New Mallophaga*, i, p. 117, Pl. 7, f. 5, 6 (1896).

Lipeurus varius Kellogg, *ibid.*, p. 116, Pl. 7, f. 3, 4 (1896).

Described by both Giebel and Piaget from specimens taken off *Daption capensis* (Cape sea-pigeon). Kellogg's specimens were found on the exotic bird, *Fulmaris glupischa.*

16. **Esthiopterum obscurum** (Rudow).

Lipeurus obscurus Rudow, *Zeit. f. ges. Nat.*, XXXVI, p. 125 (1870).

Lipeurus melanocnemis Giebel, *Ins. Epiz.*, p. 233 (1874).

Lipeurus tricolor Piaget, *Pédiculines*, p. 363, Pl. 30, f. 4 (1880).

Lipeurus lepturus Enderl., *Deutsch. Süd. polar Exp.*, X, p. 453 (1909).

Lipeurus gaini Neumann, *Deux Exp. Antarct. Fr.*, p. 192 (1913).

Described by Rudow, Giebel and Neumann from specimens taken off *Macronectes giganteus* (giant petrel), and by Piaget from the sooty albatross, *Phoebetria palpebrata (= P. fuliginosa).* Kellogg (1914) has recorded it from *Thalassarche melanophrys* (mollymawk) and *Nealbatrus chlororhynchus* (yellow-billed mollymawk) in the South Atlantic.

17. **Esthiopterum parviceps** (Piaget).

Lipeurus parviceps Piaget, *Pédiculines*, p. 321, Pl. 26, f. 6 (1880).

Described from specimens taken off *Sterna hirundo* (common tern).

18. **Esthiopterum rotundatum** (Piaget).

Lipeurus rotundatus Piaget, *Tijd. v. Ent.*, XXXI, p. 159, Pl. 4, f. 2 (1888).

Described from specimens taken off Peter's finfoot, *Podica petersi (= P. senegalensis).*

19. **Esthiopterum stellare** (Denny).

Lipeurus stellaris Denny, *Anoplur. Brit.*, p. 178, Pl. 15, f. 3 (1842).

Described from specimens taken off *Botaurus stellaris* (bittern).

20. **Esthiopterum subsignatum** (Giebel).

Lipeurus subsignatus Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 384 (1866).

Lipeurus subsignatus (Gie.) Piaget, *Pédiculines*, p. 320, Pl. 26, f. 5 (1880).

Described from specimens taken off greater flamingo, *Phoenicopterus major (= P. antiquorum).*

21. **Esthiopterum sudanicum** (Mjöberg).

Lipeurus sudanicus Mjöberg, *Arkir. f. Zool.*, VI, p. 85 (1910).

Described from specimens taken off red-eyed turtle-dove, *Streptopelia semitorquata (= Turtur semitorquatus)* in the Sudan. Bedford (1919) has recorded it taken off the laughing dove, *Stigmatopelia senegalensis aequatorialis (= Turtur senegalensis)* and Damara turtle dove, *Afropelia capicola damarensis (= T. capicola damarensis)* in the Transvaal.

Genus Columbicola Ewing.

Columbicola Ewing, *A Manual of External Parasites*, pp. 116 & 190 (1929).

Genotype: *Esthiopterum columbae* (Linné).

1. **Columbicola columbae** (Linnaeus).

Pediculus columbae Linné, *Syst. Nat.*, p. 614 (1758).

Lipeurus baculus Nitzsch in Giebel, *Zeit. f. ges. Nat.*, XXVII, p. 379 (1866).

Lipeurus baculus (Nitz.) Piaget, *Pédiculines*, p. 303, Pl. 25, f. 2 (1880).

This species is a common parasite on domestic pigeons in South Africa. Waterston (1914) has recorded it taken off *Vinago delalandei* (Cape fruit pigeon) at Port St. Johns, Cape Province, and Bedford (1919) from laughing dove, *Stigmatopelia senegalensis aequatorialis (= Turtur senegalensis)* and Damara turtle dove, *Afropelia capicola damarensis (= T. capicola damarensis)* in the Transvaal.

Genus Rallicola Johnston & Harrison.

Oncophorus Piaget, *Pédiculines*, p. 213 (1880), *nec* Rudow (1870).

Rallicola Johnston & Harrison, *Proc. Linn. Soc. N.S. Wales*, XXXVI, p. 324 (1911).

This genus includes seventeen species, the majority having been found on Rallidae.

Genotype: *Nirmus attenuatus* Nitzsch.

1. **Rallicola cuspidata** (Scopoli).

Nirmus cupidatus Scopoli, in Denny, Anoplur. Brit., p. 130, Pl. 6, f. 2 (1842).

Oncophorus minutus Piaget, Pédiculines, p. 215, Pl. 18, f. 2 (1880) *nec* Nitzsch, 1866.

Harrison (1916) sunk both *N. fulicae* Denny and *N. minutus* Nitzsch as synonyms of *cuspidata*, but these include two species. Both occur on several species of Rallidae and may be found on the same hosts. It is difficult to be absolutely certain, without examining Denny's specimens, which one should be referred to the insect he described as *N. cuspidatus* and which one to his *N. fulicae* *. In the one species, which I refer to *cuspidatus*, the first joint of the ♂ antenna is only slightly longer than that of the ♀ and about as broad, and there is no appendage on the third joint. In the other species, *fulicae*, the first joint of the ♂ antenna is much broader and nearly as long as the four following joints, and the third joint has a very small appendage. Piaget (p. 216, 1880) was therefore incorrect in stating: " Giebel en exagère na longueur en disant qu'elle égale à peu prèscelle des 4 autres articles ". Other differences are to be found in the ♂ genitalia. *R. cuspidata* was described by Scopoli from specimens taken off *Fulica atra*, by Denny from *Gallinula chloropus* and *Rallus aquaticus*, and by Piaget from species of *Gallinula*. Specimens have also been taken off *Gallinula chloropus brachyptera* (African moorhen), *Porphyriops angulata* (lesser moorhen) and *Lupha cristata* (red-knobbed coot) in the Rustenburg District, Transvaal (coll. W. Powell).

2. **Rallicola fulica** (Denny).

Nirmus fulicae Denny, Anoplur. Brit., p. 125, Pl. 9, f. 2 (1842).

Nirmus minutus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 375 (1866).

Nirmus minutus (Nitz.) Giebel, Ins. Epiz., p. 170, Pl. 5, f. 7 (1874).

Described by both Denny and Giebel from specimens taken off *Fulica atra*, also by Giebel from *Gallinula chloropus*. Specimens have been taken off *Gallinula chloropus brachyptera* (African moorhen) and *Lupha cristata* (red-knobbed coot) in the Rustenburg District, Transvaal (coll. W. Powell). See remarks under *R. cuspidata*.

3. **Rallicola mystax** (Giebel).

Nirmus mystax Giebel, Ins. Epiz., p. 301 (1874).

Described from specimens taken off *Ortygometra porzana* (spotted crake), a migrant from Europe.

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* I am indebted to Mr. Gordon B. Thompson of the British Museum (Nat. History) for kindly comparing the type ♂ of *N. fulicae* Denny with Piaget's *O. minuta*. He informs me that they are distinct, and that in *N. fulicae* the first joint of the antenna is long and the third joint has a small appendage. Unfortunately he states that Denny's *N. cuspidatus* is missing from the collection. However, the names of *cuspidata* can stand as Denny was apparently able to distinguish the two species.

4. **Rallicola ortygometrae** (Schrank).

Pediculus ortygometrae Schrank, *Ins. Aust.*, p. 503 (1781).

Nirmus attenuatus Nitzsch, in Denny, Anoplur. Brit., p. 134, Pl. 10, f. 2 (1842).

Oncophorus attenuatus (Nitz.) Piaget, *Pédiculines*, p. 214, Pl. 18, f. 1 (1880).

Described from specimens taken off corn crake, *Crex crex (= Crex pratensis)*, a migrant to South Africa.

5. **Rallicola turbinata** (Piaget).

Oncophorus turbinatus Piaget, *Tijd. v. Ent.*, XXIII, p. 233, Pl. 8, f. 10 (1888).

Described from specimens taken off saddle-bill stork, *Ephippiorhynchus senegalensis (= Mycteria senegalensis)*.

Genus Giebelia Kellogg.

Giebelia Kellogg, New Mallophaga, I, p. 137 (1896).

This genus contains three species found on petrels.

Genotype: *Giebelia mirabilis* Kellogg.

1. **Giebelia hexakon** Waterston.

Giebelia hexakon Waterst., *Ann. S. Afr. Mus.*, X, p. 291 (1914).

Described from specimens taken off Cape hen, *Procellaria aequinoctialis (= Majaqueus aequinoctialis)* in South Africa. Specimens have also been taken off *Ardenna gravis* (great shearwater) at Capetown (coll. R. F. Lawrence).

Genus Trabeculus Rudow.

Trabeculus Rudow, *Zeit. f. ges. Nat.*, XXVII, p. 466 (1866).

Oncophorus Rudow, *ibid.*, XXXV, p. 475 (1870).

Mackayia Waterston, *Scottish Naturalist*, p. 251 (1912).

This genus contains two species.

Genotype: *Trabeculus schillingi* Rudow.

1. **Trabeculus schillingi** Rudow.

T. schillingi Rudow, *Zeit. f. ges. Nat.*, XXVII, p. 467 (1866).

Oncophorus schillingi (Rud.) Piaget, *Pédiculines*, p. 221 (1880).

Mackayia heteracanthus Waterston, *Scott. Nat.*, p. 258 (1912).

Mackayia heteracanthus Waterston, *Ann. S. Afr. Mus.*, X, p. 292, Pl. 25, f. 8; Pl. 26, f. 13, 16, 18 (1914).

Described by Rudow from specimens taken off soft-plumaged petrel, *Pterodroma mollis (= Procellaria mollis)*. Waterston (1914) recorded it taken from giant petrel, *Macronectes giganteus (= Procellaria gigantea)* and *Oceanites oceanicus* (sooty petrel) in South Africa. Specimens have also been taken off *Pterodroma macroptera* (Cape parson) at Capetown (coll. R. F. Lawrence).

Genus Docophoroides Giglioli.

Docophoroides Giglioli, *Quart. Journ. Micr. Science*, IV, p. 21 (1864).

Eurymetopus Taschenberg, *Nova Acta, Halle*, XLIV, p. 182 (1882).

Taschenbergius Neumann, *Bull. Soc. Zool. France*, XX, p. 59 (1906).

Taschenbergiella Neumann, *Deux. Exp. Ant., France*, p. 195 (1913).

This genus includes five species found on Diomedeidae and Hydrobatidae, four of which have been recorded from South Africa. For differences in the females see Bedford (1929).

Genotype: *Philopterus brevis* Dufour.

1. **Docophoroides brevis** (Dufour).

Philopterus brevis Dufour, *Ann. Soc. Ent.*, IV, p. 676, Pl. 21, f. 3 (1834).

Lipeurus taurus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 385 (1866).

Lipeurus taurus (Nitz.) Giebel, *Ins. Epiz.*, p. 234 (1874); Piaget *Pédiculines*, p. 332, Pl. 31, f. 3 (1880); Taschenberg, *Nova Acta*, p. 183, Pl. 5, f. 8, 8a (1882).

This species has been recorded by Waterston (1914) taken off the following hosts in the Cape: *Diomedea exulans* (wandering albatross); yellow-billed mollymawk, *Nealbatrus chlororhynchus (= Thalassogeron chlororhynchus)*, and Cape hen, *Procellaria aequinoctialis (= Majaqueus aequinoctialis)*.

2. **Docophoroides harrisoni** (Waterston).

Eurymetopus harrisoni Waterston, *Ent. Mo. Mag.* (3), III, p. 99 (1917).

Described from specimens taken off mollymawk, *Thalassarche melanophrys (= Diomedea melanophrys)* in South Africa. Recorded by Bedford (1929) taken off the same host at Capetown in July, 1923. We have also received specimens taken off *Diomedella cauta layardi* (Layard's albatross) at Dyers Island.

3. **Docophoroides murphyi** (Kellogg).

Eurymetopus murphyi Kellogg, *Brooklyn Sci. Bull.*, II, p. 87, Pl. 16, f. 4, 5 (1914).

Recorded by Bedford (1929) taken off *Macronectes giganteus* (giant petrel) at Capetown, C.P., November, 1923. This species was described from specimens taken off the following hosts in the South Atlantic: Mollymawk, *Thalassarche melanophrys (= Diomedea melanophrys); Macronectes giganteus (= Ossifraga gigantea)* and yellow-billed mollymawk, *Nealbatrus chlororhynchus (= Thalassogeron nealbatrus chlororhynchus)*.

4. **Docophoroides simplex** (Waterston).

Eurymetopus simplex Waterston, *Ann. S. Afr. Mus.*, X, p. 303 (1914).

Described from specimens taken off mollymawk, *Thalassarche melanophrys* (= *Diomedea melanophrys*) and Cape hen, *Procellaria aequinoctialis* (= *Majaqueus aequinoctialis*). We have also received specimens taken off *D. melanophrys* at Dyers Island.

Genus IBIDOECUS Cummings.

Ibidoecus Cummings, *Proc. Zool. Soc. Lond.*, p. 663 (1916).

This genus contains six species found on ibises and spoonbills.

Genotype: *Docophorus plataleae* Denny.

1. **Ibidoecus plataleae** (Denny).

Docophorus plataleae Denny, *Anoplur. Brit.*, p. 109, pl. 4, f. 9 (1842).

D. sphenophorus Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 361 (1866).

D. sphenophorus (Nitz.) Piaget, *Pédiculines*. p. 89, Pl. 7, f. 5 (1880).

Recorded by Bedford (1920) taken off *Platalea alba* (African spoonbill) in the Pretoria District, Transvaal. It was described by Denny from specimens taken off *Platalea leucorodia*, which was killed at Yarmouth, Norfolk, in 1829.

2. **Ibidoecus threskiornis** Bedford.

I. threskiornis Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 526, f. 30, 31 (1929).

Described from ♀♀ and ♂♂ taken off *Threskiornis aethiopica* (sacred ibis) at Emakosini, Zululand.

Genus NEOPHILOPTERUS Cummings.

Neophilopterus Cummings, *Proc. Zool. Soc. Lond.*, p. 660 (1916).

This genus contains six species found on storks.

Genotype: *Docophorus tricolor* Nitzsch.

1. **Neophilopterus abdimius** Bedford (Fig. 12).

N. abdimius Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 524, f. 27-29 (1929).

Described from ♀♀ and ♂♂ taken off *Sphenorhynchus abdimi* (white-bellied stork) at Andoni, South-West Africa.

2. **Neophilopterus episcopi** (Kellogg).

Docophorus episcopi Kell., *Schwed. Exp. Kilimanjaro*, p. 44, Pl. 7, f. 2 (1910).

Described from specimens taken off *Dissoura episcopus* (woolly-necked stork), *Ephippiorhynchus senegalensis* (saddle-bill stork) and great white heron, *Casmerodius albus* (= *Herodias alba*).

3. **Neophilopterus incompletus** (Nitzsch).

Docophorus incompletus Nitzsch, in Denny, *Anoplur. Brit.*, p. 105, Pl. 6, f. 5 (1842).

D. incompletus (Nitz.) Piaget, *Pédiculines*, p. 96, Pl. 8, f. 3 (1880).

N. incompletus (Nitz.) Cumms., *Proc. Zool. Soc. Lond.*, p. 660, f. 13 (1916).

Specimens have been taken off the type host, *Ciconia ciconia* (white stork) at Pietermaritzburg, Natal (coll. L. Hill).

4. **Neophilopterus tricolor** (Nitzsch).

Docophorus tricolor Nitzsch, in Burmeister, *Handb.*, II, p. 424 (1838).

D. tricolor (Nitz.) Piaget, *Pédiculines*, p. 83, Pl. 6, f. 5 (1880).

Described from specimens taken off black stork, *Melanopelargus niger (= Ciconia nigra)*, a migrant to South Africa. Cummings (1916) has figured the ♂ genitalia.

Genus Incidifrons Ewing.

Incidifrons Ewing, *A Manual of External Parasites*, p. 189 (1929).

This genus includes a few parasites found on Rallidae, but no species has so far been recorded from South African rails.

Genotype: *Docophorus pertusus* Nitzsch.

Genus Anatoecus Cummings.

Anatoecus Cummings, *Proc. Zool. Soc. London*, p. 653 (1916).

This genus includes seven species found on ducks, geese and swans.

Genotype: *Docophorus icterodes* Nitzsch.

1. **Anatoecus icterodes** (Nitzsch).

Docophorus icterodes Nitzsch, in Burmeister, *Handb.*, II, p. 424 (1838).

D. icterodes (Nitz.) Piaget, *Pédiculines*, p. 114, Pl. 10, f. 1 (1880).

A. icterodes (Nitz.) Cumms., *Proc. Zool. Soc. Lond.*, p. 655, f. 7b, 10, 12 (1916).

Recorded by Bedford (1919) taken off *Dendrocygna viduata* (white-faced duck) and *Thalassornis leuconotus* (white-backed duck) in the Rustenburg District, Transvaal, and from a domestic duck at Pietermaritzburg, Natal; also by Bedford (1929) from *Dendrocygna bicolor* (whistling duck), Tamanzu, South-west Africa, and *Poecilonitta erythrorhyncha* (red-billed teal). As it is not certain that Scopoli's *Pediculus dentatus* applies to this species, it has been discarded.

2. **Anatoecus ferrugineus** (Giebel).

Docophorus ferrugineus Giebel, *Ins. Epiz.*, p. 114 (1874).

A. ferrugineus (Gie.) Cumms., *Proc. Zool. Soc. Lond.*, p. 657, f. 7a, 11 (1) (1916).

Recorded by Bedford (1919) taken off *Sarkidiornis melanotus africanus* (knob-billed duck) in the Rustenburg District, Transvaal. The type was taken from European shoveller, *Spatula clypeata (= Anas clypeata).*

Genus Dollabella Cummings.

Dollabella Cummings, *Proc. Zool. Soc. London*, p. 675 (1916).

Genotype: *Docophorus testudinarius* Denny.

1. **Dollabella testudinaria** (Denny).

Docophorus testudinarius Denny, *Anoplur. Brit.*, p. 96, Pl. 1, f. 6 (1842).

Docophorus testudinarius (Denny) Piaget, *Pédiculines*, p. 83, Pl. 6, f. 5 (1880).

Dollabella testudinarius (Denny) Cumms., *Proc. Zool. Soc. Lond.*, p. 675, f. 23 (1916).

Described from specimens taken off *Numenius arquatus* (curlew). Cummings (1916) recorded it from *Phaeopus phaeopus* (whimbrel). Both hosts are migrants to South Africa.

Genus Eustrigiphilus Ewing.

Eustrigiphilus Ewing, *Proc. Ent. Soc. Wash.*, XXVIII, vi, p. 148 (1926).

This genus comprises three or four species found on owls.

Genotype: *Docophorus ceblebrachys* Nitzsch.

1. **Eustrigiphilus ceblebrachys** (Nitzsch).

Docophorus ceblebrachys Nitzsch, in Denny, *Anoplur. Brit.*, p. 81, Pl. 2, f. 8 (1842).

Docophorus ceblebrachys (Nitz.) Piaget, *Pédiculines*, p. 29, Pl. 1, f. 8 (1880).

Recorded by Bedford (1920) taken off giant eagle owl, *Nyctaetus lacteus (= Bubo lacteus)* in the Rustenburg District, Transvaal. The type host is *Nyctea nivea.*

Genus Cuculoecus Ewing.

Cuculoecus Ewing, *Proc. Ent. Soc.* Wash., XXVIII, vi, p. 148 (1926).

This genus includes a few species parasitic on cuckoos and bee-eaters. Those found on bee-eaters will ultimately have to be placed in a new genus.

Genotype: *Docophorus coccygi* Osborn.

1. **Cuculoecus latifrons** (Nitzsch).

Docophorus latifrons Nitzsch, in Denny, *Anoplur. Brit.*, p. 97, Pl. 1, f. 4 (1842).

Docophorus latifrons (Nitz.) Piaget, *Pédiculines*, p. 36, Pl. 2, f. 7 (1880).

Described from specimens taken off *Cuculus canorus* (European cuckoo), a migrant to South Africa.

2. **Cuculoecus meropis** (Denny).

Docophorus meropis Denny, *Anoplur. Brit.*, p. 101, Pl. 4, f. 4 (1842).

Docophorus bifrons Nitzsch, *Zeit. f. ges. Nat.*, XXVII, p. 116 (1866).

Docophorus bifrons (Nitz.) Piaget, *Pédiculines*, p. 62, Pl. 7, f. 1 (1880).

Specimens have been taken off the type host, *Merops apiaster* (European bee-eater) and *Melittophagus pusillus meridionalis* (little bee-eater) at Onderstepoort, Transvaal (coll. G.A.H.B.); also off *Coccolarynx bullockoides* (white-fronted bee-eater) in the Rustenburg District, Transvaal.

Genus Philopterus Nitzsch.

Philopterus Nitzsch, *Germar's Magazin*, III, p. 288 (1818).

Docophorus Nitzsch, *ibid.*, III, p. 289 (1818).

This genus, which will have to be split up, contains over 200 species found on various birds.

Genotype: *Pediculus ocellatus* Scopoli.

1. **Philopterus acanthus** (Giebel).

Docophorus acanthus Giebel, *Ins. Epiz.*, p. 101 (1874).

Docophorus acanthus (Gie.) Piaget, *Pédiculines*, p. 84, Pl. 6, f. 6 (1880).

Mjöberg (1910) has recorded this species from the following birds: Bar-tailed godwit, *Vetola lapponica (= Limosa lapponica)* and whimbrel, *Phaeopus phaeopus (= Numenius phaeopus)*, both migrants to South Africa. The type host is *Haematopus ostralegus*.

2. **Philopterus antennatus** (Piaget).

Docophorus antennatus Piaget, *Pédiculines*, p. 101, Pl. 8, f. 6 (1880).

Described from specimens taken off *Dromas ardeola* (crab plover), a migrant to South Africa.

3. **Philopterus aquilinus** (Denny).

Docophorus aquilinus Denny, *Anoplur. Brit.*, p. 81, pl. 2, f. 7 (1842).

Described from specimens taken off *Aquila spp.* and honey buzzard, *Pernis apivorus (= Falco apivorus)*, a migrant to South Africa.

4. **Philopterus auratus** (Nitzsch).

Docophorus auratus Nitzsch, in Burmeister, *Handbuch*, II, p. 424 (1838).

Docophorus auratus (Nitz.) Piaget, *Pédiculines*, p. 78, Pl. 5, f. 8 (1880).

Recorded by Giebel (p. 108, 1874) taken from double snipe, *Capella media* (= *Scolopax major*), a migrant; also from the type host, *Scolopax rusticola*.

5. **Philopterus atlanticus** (Kellogg).

Docophorus atlanticus Kellogg, *Brooklyn Sci. Bull.*, II, iv, p. 81, Pl. 16, f. 1 (1914).

Described from specimens taken off white-necked skua, *Stercorarius parasiticus* (= *S. crepidatus*) in the North Tropical Atlantic, and from Artic tern, *Sterna macrura* (= *S. paradisea*) in the South Atlantic. Both these hosts occur on the South African coast.

6. **Philopterus capistratus** Neumann.

Philopterus capistratus Neu., *Arch. Parasit.*, XV, p. 375, f. 20 (1912).

Recorded by Bedford (1919) taken off brown-hooded kingfisher, *Chelicutona albiventris* (= *Halcyon albiventris*) at Mooivlei, Transvaal, and at Pietermaritzburg, Natal. It was described from specimens taken off *Halcyon semicaeruleus.*

7. **Philopterus cephalus** (Denny).

Docophorus cephalus Denny, *Anoplur Brit.*, p. 81, Pl. 2, f. 8 (1842).

Described from specimens taken off white-necked skua, *Stercorarius parasiticus* (= *Lestris parasiticus*), and large white-necked skua, *Coprotheres pomarinus* (= *Lestris pomarinus*).

8. **Philopterus conicus** (Denny).

Docophorus conicus Denny, *Anoplur. Brit.*, p. 90, Pl. 5, f. 2 (1842).

Docophorus fuliginosus Kellogg, *New Mallophaga*, i, p. 80, Pl. 3, f. 2 (1896).

Recorded from several species of Charadriidae, including *Squatarola squatarola* (grey plover), a migrant to South Africa. Denny described it from specimens taken off *Charadius pluvialis.*

9. **Philopterus cornutus** (Piaget).

Docophorus pachypus var cornuta Piaget, *Pédiculines*, p. 21 (1880).

Recorded from *Pernis apivorus* (honey buzzard), a migrant to South Africa. Piaget described it from specimens taken off *Falco bidentatus.*

10. **Philopterus cursor** (Nitzsch).

Docophorus cursor Nitzsch, in Burmeister, *Handb.*, II, p. 426 (1838).

Docophorus cursor (Nitz.) Piaget, *Pédiculines*, p. 24, Pl. 1, f. 5 (1880).

Philopterus cursor (Nitz.) Cummings, *Proc. Zool. Soc. Lond.*, p. 644, f. 1 (1916).

Waterston (1914) recorded this species from *Bubo capensis* (Cape eagle owl) and spotted eagle owl, *Bubo africanus (= B. maculosus)* in South Africa. Bedford (1919, 1920) also recorded it from *Bubo africanus*, Onderstepoort, and from *Bubo capensis*; giant eagle owl, *Nyctaetus lacteus (= B. lacteus)*, and Woodford's bush owl, *Syrnium woodfordi (= Strix woodfordi)* in the Rustenburg District, Transvaal. A ♀ has been taken off *Phasmaptynx capensis* (Cape marsh owl) in the Pretoria District.

11. **Philopterus duplicatus** (Piaget).

Docophorus duplicatus Piaget, *Tijd. v. Ent.*, XXXIII, p. 223, Pl. 8, f. 1 (1888).

Docophorus cerylinus Mjöberg, *Arkiv. f. Zool.*, VI, p. 119, f. 67, 68 (1910).

Recorded by Bedford (1919) taken off the type host, *Ceryle rudis* (pied kingfisher) at Mooivlei, Transvaal.

12. **Philopterus elongatus** (Piaget).

Docophorus elongatus Piaget, *Pédiculines*, Suppl., p. 15, Pl. 2, f. 4 (1885).

Described from specimens taken off *Rhynchops flavirostris* (African skimmer) in the Leyden Museum.

13. **Philopterus exisus** (Nitzsch).

Docophorus excisus Nitzsch, in Burmeister, *Handb.*, II, p. 425 (1838).

Docophorus hirundinis "Shrank" Piaget,, *Tijd. v. Ent.*, XIV, p. 134, Pl. 7, f. 13 (1871).

Docophorus excisus (Nitz.) Piaget, *Pédiculines*, p. 64, Pl. 4, f. 6 (1880).

Recorded by Waterston (1914) taken off *Hirundo rustica* (European swallow), and by Bedford (1919) from the type host, the house martin, *Chelidonaria urbica (= Chelidon urbica)* in South Africa.

14. **Philopterus fusiformis** (Denny).

Docophorus fusiformis Denny, *Anoplur. Brit.*, p. 84, Pl. 1, f. 2 (1842).

Docophorus canuti Denny, *ibid.*, p. 84, Pl. 3, f. 5 (1842).

Docophorus fusiformis (Denny) Piaget, *Pédiculines*, p. 86, Pl. 6, f. 7 (1880).

Described by Denny from specimens taken off little stint, *Pisobia minuta (= Tringa minuta)* and Knot, *Calidris canutus (= Tringa canutus)*. Piaget (1880) described it from curlew sandpiper, *Erolia testacea (= Tringa subarquata)*. All these hosts are migrants to South Africa.

15. **Philopterus glareolae** (Giebel).

Docophorus glareolae Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 361 (1866).

Docophorus nitzschi Giebel, *ibid.*, p. 361 (1866).

Docophorus cordiceps Giebel, *Ins. Epiz.*, p. 103 (1874).

Described by Giebel under all three names from specimens taken off wood sandpiper, *Rhyncophilus glareola (= Totanus glareola).* Harrison (1916) sunk *P. cordiceps* Piaget as a synonym of *P. temporalis* Giebel, but it is a synonym of *P. frater* Giebel.

16. **Philopterus gonothorax** (Giebel).

Pediculus lari Fabr., *Faun. Groen.*, p. 219 (1780) *nec* Degeer, 1778.

Docophorus gonothorax Giebel, *Zeit. f. ges. Nat.*, XXXVII, p. 450 (1871).

Docophorus congener Giebel, *Ins. Epiz.*, p. 111 (1874).

Docophorus lari (D.) Piaget, *Pédiculines*, p. 111, Pl. 9, f. 7 (1880).

D. lari var. magna Piaget, *ibid*, p. 112 (1880).

D. lari var. breviappendiculata Piaget, *ibid.*, p. 112 (1880).

Waterston (1914) recorded this species from the following hosts in South Africa: Mollymawk, *Thallassarche melanophrys (= Diomedea melanophrys); Larus dominicanus* (Cape black-backed-gull), and white-headed gull, *Bruchigavia novae-hollandiae hartlaubi (= Larus hartlaubi).*

17. **Philopterus humeralis** (Denny).

Docophorus humeralis Denny, *Anoplur. Brit.*, p. 88, Pl. 5, f. 7 (1842).

Described by Denny from specimens taken off *Numenius arquatus* (curlew). He also recorded it from *Phaeopus phaeopus* (whimbrel). Both hosts are migrants to South Africa.

18. **Philipterus lanii** (Fabricius).

Pediculus lanii Fabr., *Ent. Syst.*, Suppl., p. 570 (1798).

Docophorus fuscicollis Nitzsch, in Burmeister, *Handb.*, II, p. 425 (1838).

Docophorus trigonophorus Giebel, *Ins. Epiz.*, p. 87 (1874).

D. communis var. fuscicollis (N.) Piaget, *Pédiculines*, p. 56 (1880).

Described from specimens taken off red-backed shrike, *Enneoctonus collurio (= Lanius collurio)*, a migrant to South Africa.

19. **Philopterus laricola** (Nitzsch).

Docophorus laricola Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 363 (1866).

Docophorus laticaudatus Rudow, *Beitrag*, p. 12 (1869).

Docophorus laricola (N.) Piaget, *Pédiculines*, p. 109, Pl. 9, f. 5 (1880).

Described by Piaget from specimens taken off little tern, *Sternula albifrons* (= *Sterna minuta*) and *Sterna hirundo* (common tern). Harrison (1916) for some unknown reason sunk *laricola* as a synonym of *melanocephalus*.

20. **Philopterus leptomelas** (Giebel).

Docophorus leptomelas Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 358 (1866).

Described from specimens taken off *Corvultur albicollis* (white-necked raven).

21. **Philopterus limosae** (Denny).

Docophorus limosae Denny, *Anoplur. Brit.*, p. 86, Pl. 4, f. 2 (1842).

Docophorus limosae (Denny) Piaget, *Pédiculines*, p. 79, Pl. 6, f. 1 (1880).

Described from specimens taken off black-tailed godwit, *Limosa limosa* (= *L. melanurus*), a migrant.

22. **Philopterus macropus** (Giebel).

Docophorus macropus Giebel, *Ins. Epiz.*, p. 301 (1874).

Described from specimens taken off *Caprimulgus europeus* (European nightjar), a migrant.

23. **Philopterus major** (Waterston).

Docophorus nirmoides Piaget, *Pédiculines*, p. 104, Pl. 9, f. 2 (1880), *nec.* Nitzsch, 1861.

Docophorus nirmoides var. major Waterston, *Ent. Month. Mag.*, p. 62 (1912).

Described by Piaget from specimens taken off *Numenius arquatus* (curlew), a migrant. It was described by Waterston from specimens taken off *Scolopax gallinago*.

24. **Philopterus melanocephalus** (Nitzsch).

Docophorus melanocephalus Nitzsch, in Burmeister, *Handb.*, II, p. 426 (1838).

D. lobaticeps Giebel, *Ins. Epiz.*, p. 109 (1874).

D. melanocephalus (N.) Piaget, *Pédiculines*, p. 109, Pl. 9, f. 5 (1880).

Recorded by Waterston (1914) taken off swift tern, *Thallaseus bergii* (= *Sterna bergii*) in South Africa. It has also been taken off the same host at Swakopmund, South-West Africa (coll. R. D. Bradfield) and *Sterna hirundo* (common tern) at Port Alfred, C.P. (coll. G.A.H.B.). Piaget (1880) described it from sandwich tern, *Thalasseus sandricensis* (= *S. cantiaca*).

25. **Philopterus milvi** (Mjöberg).

Docophorus milvi Mjöberg, *Arkiv. f. Zool.*, VI, p. 109, f. 63 (1910).

Described from specimens taken off *Milvus aegypticus* (yellow-billed kite) at Cairo. It has been collected on the same host in Zululand by H. H. Curson.

26. **Philopterus naumanni** (Giebel).

Docophorus naumanni Giebel, *Ins. Epiz.*, p. 100 (1874).

Described from specimens taken off grey plover, *Squatarola squatarola (= Venellus squatarola)*, a migrant to South Africa.

27. **Philopterus nisi** (Denny).

Docophorus nisi Denny, *Anoplur. Brit.*, p. 109, Pl. 3, f. 11 (1842).

Docophorus gonorhynchus Giebel, *Zeit. f. ges. Nat.*, XVII, p. 526 (1861).

Docophorus gonorhynchus (G.) Piaget, *Pédiculines*, p. 20, Pl. 1, f. 3 (1880).

Recorded from *Circus aeruginosus* (European marsh harrier). The type host is *Accipiter nisus.*

28. **Philopterus ornatus** (Nitzsch).

Docophorus ornatus Nitzsch, *Zeit. f. ges. Nat.*, XXVII, p. 116 (1866).

D. communis var. ornatus (N.) Piaget, *Pédiculines*, p. 51, Pl. 4, f. 2 (1880).

Described from specimens taken off European golden oriole, *Oriolus oriolus (= O. galbula)*, a migrant. Bedford (1920) recorded it from *Oriolus larvatus* (black-headed oriole), Pietermaritzburg, Natal.

29. **Philopterus ovatus** (Giebel).

Docophorus ovatus Giebel, *Ins. Epiz.*, p. 98 (1874).

Described from specimens taken off *Botaurus stellaris* (bittern).

30. **Philopterus platyclypeatus** (Piaget).

Docophorus platyclypeatus Piaget, *Tijd. v. Ent.*, XIV, p. 133, Pl. 7, f. 12 (1871).

Docophorus platyclypeatus Piaget, *Pédiculines*, p. 100, Pl. 8, f. 4 (1880).

Described from specimens taken off *Anastomas lamelligerus* (open-bill stork).

31. **Philopterus platygaster** (Denny).

Docophorus platygaster Denny, *Anoplur. Brit.*, p. 83, Pl. 2, f. 5 (1842).

Docophorus semivittatus Giebel, *Ins. Epiz.*, p. 102 (1874).

Docophorus semivittatus (Gie.) Piaget, *Pédiculines*, p. 82, Pl. 6, f. 4 (1880).

Described by Denny from specimens taken off *Charadrius hiaticula* (ringed plover) and other birds. Waterston (1914) recorded it under the name of *D. cordiceps* Piaget taken from the following hosts in South Africa: White-fronted sandplover, *Leucopolius marginatus (= Aegialitis marginata)*; Kittlitz's sandplover, *Leucopolius pecuaria (= A. pecuaria)*, and three-banded sandplover, *Afroxechus tricollaris (= Aegialitis tricollaris)*.

32. **Philopterus platyrhynchus** (Nitzsch).

Docophorus platyrhynchus Nitz., in Giebel, *Zeit. f. ges. Nat.*, XVII. p. 525 (1861).

Docophorus dilatatus Rudow, *Beitrag*, p. 14 (1869).

Docophorus eurygaster Giebel, *Ins. Epiz.*, p. 69 (1874).

Docophorus leucogaster Giebel, *ibid.*, p. 300 (1874).

Type host of *platyrhynchus: Astur palumbarius*; of *dilatatus* and *eurygaster: Buteo lagopus*, and of *leucogaster*: jackal buzzard, *Pterolestes rufofuscus (= Buteo jakal)*. Recorded by Waterston (1914) taken off the last named host in South Africa.

33. **Philopterus pustulosus** (Nitzsch).

Docophorus pustulosus Nitz., in Giebel, Zeit. f. ges. Nat., XXVIII, p. 363 (1866).

Docophorus euryrhynchus Giebel, *Ins. Epiz.*, p. 112 (1874).

Docophorus pustulosus (N.) Piaget, *Pédiculines*, p. 106, Pl. 9, f. 4 (1880).

Described by both Giebel (1874) and Piaget (1880) from specimens taken off large white-necked skua, *Coprotheres pomarinus (= Lestris pomarina)*. *P. pustulosus* was described from specimens taken off *Lestris parasitica*.

34. **Philopterus pygaspis** (Nitzsch).

Docophorus pygaspis Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 310 (1866).

Docophorus pilosus Piaget, *Pédiculines*, p. 116, Pl. 10, f. 4 (1880).

Docophorus phoenicopterus Mjöberg, *Arkiv. f. Zool.*, VI, p. 127 (1910).

Described from specimens taken off *Phoenicopterus antiquorum* and *P. roseus*, both names being synonyms of *P. major* (greater flamingo).

35. **Philopterus quinquemaculatus** (Piaget).

Docophorus quinquemaculatus Piaget, *Pédiculines*, Suppl. p. 9, Pl. 1, f. 10 (1885).

Described from speimens taken off house martin, *Chelidonaria urbica (= Hirundo urbica)*.

36. **Philopterus rostratus** (Nitzsch).

Docophorus rostratus Nitzsch, in Burmeister, *Handb.*, II, p. 427 (1838).

Docophorus rostratus (N.) Denny, *Anoplur. Brit.*, p. 87, Pl. 2, f. 4 (1842).

Docophorus rostratus (N.) Piaget, *Pédiculines*, p. 27, Pl. 1, f. 7 (1880).

Recorded by Waterston (1914) from Cape spotted eagle owl, *Bubo africanus (= B. maculosus)*, and by Bedford (1920) from Cape barn owl, *Tyto alba affinis (= Strix flammea maculata)*.

37. **Philopterus rotundus** (Rudow).

Docophorus rotundus Rudow, *Beitrag.*, p. 11 (1869).

Docophorus rotundus (Rud.) Piaget, *Pédiculines*, p. 85 (1880).

Described from specimens taken off whimbrel, *Phaeopus phaeopus (= Numenius phaeopus)*, a migrant to South Africa.

38. **Philopterus semisignatus** (Nitzsch).

Docophorus semisignatus Nitzsch, in Burmeister, *Handb.*, II, p. 424 (1838).

Docophorus albidus Piaget, *Pédiculines*, p. 48, Pl. 3, f. 6 (1880).

Described by Piaget from specimens taken off pied crow, *Corvus albus (= C. scapulatus)* in the Leyden Museum.

39. **Philopterus senegalensis** (Rudow).

Docophorus senegalensis Rudow, *Beitrag.*, p. 10 (1869).

Docophorus senegalensis (Rud.) Piaget, *Pédiculines*, p. 70 (1880).

Recorded by Bedford (1920) from *Lamprocolius phoenicopterus* (red-shouldered glossy starling), Pietermaritzburg, Natal, and from *L. phoenicopterus bispecularis* (lesser red-shouldered starling), Cumberland, Transvaal. The type was found on *L. nitens*.

40. **Philopterus spathulatus** (Giebel).

Docophorus spathulatus Giebel, *Ins. Epiz.*, p. 73 (1874).

Docophorus penicillatus Piaget, *Pédiculines*, p. 22 (1880).

Described by Piaget from specimens taken off *Milvus aegyptius* (yellow-billed kite) and the type host, the black kite, *Milvus migrans (= M. ater)*.

41. **Philopterus sturni** (Schrank).

Pediculus sturni Schrank, *Beiträge z. Naturg.*, p. 118, f. 11-14 (1776).

Docophorus leontodon Nitz., in Burmeister, *Handb.*, II, p. 425 (1838).

Docophorus pastoris Denny, *Anoplur. Brit.*, p. 77, Pl. 4, f. 3 (1842).

Docophorus leontodon (N.) Piaget, *Pédiculines*, p. 66, Pl. 5, f. 1 (1880).

This species occurs on *Sturnus vulgaris* (European starling), but has not yet been recorded from South Africa.

42. **Philopterus subflavescens** (Geoffroy).

Pediculus subflavescens Geoff., *Hist. Abs. Ins.*, II, p. 599 (1762).

Docophorus communis Nitzsch, in Burmeister, *Handb.*, II, p. 425 (1838).

Docophorus communis (N.) Piaget, *Pédiculines*, p. 54, Pl. 4, f. 5 (1880).

This species has been recorded from numerous passerine birds under different names (see Harrison 1916), a number of which will ultimately prove to be valid. Bedford (1920) has recorded it from the following hosts in South Africa: Cape ferrugineous bush-shrike, *Laniarius ferrugineus (= Dryoscopus ferrugineus); Alseonax adustus* (Cape dusky flycatcher), and Cape black-headed sparrow, *Passer melanurus (= P arcuatus).* It has also been recorded from the following birds in Europe, all of which are migrants to South Africa: Spotted flycatcher, *Muscicapa striata (= M. grisola)*; icterine warbler, *Hippolais coelebs (=Sylvia hippolais);* common whitethroat, *Sylvia curruca*, and European sedge warbler, *Muscipeta schoenobaena (= Sylvia phragmitis).*

43. **Philopterus sulcatus** (Piaget).

Docophorus sulcatus Piaget, *Tijd. v. Ent.*, XXXI, p. 149, Pl. 3, f. 2 (1888).

Described from specimens taken off little bittern, *Ixobrychus minutus (= Ardetta minuta).*

Family TRICHODECTIDAE Burmeister.

This family comprises a number of species parasitic chiefly on Carnivora, Equidae, Bovidae and Procaviidae.

Key to the South African Genera.

1. Claws of mid and hind legs spinose-serrate on their inner margins. On Procaviidae ... ... *Dasyonyx*, p. 359.
   Claws of the legs simple 2
2. Head nearly twice as broad as long, with long, pointed processes on the posterior margins in both sexes. On Procaviidae ... ... *Eurytrichodectes*.
   Head at most only slightly broader than long 3
3. Forehead triangular or subtriangular, with or without a median notch in front 4
   Forehead not triangular or subtriangular 6
4. Forehead subtriangular, with a median notch 5
   Forehead triangular. On Felidae and Viverridae *Felicola*, p. 365.

5. Tergites with median transverse sclerites. On Procaviidae *Procavicola*, p. 357.
   Tergites without transverse sclerites, with the exception of a transverse plate on tergite viii of ♀. On aardwolf *Protelicola*, p. 365
6. Forehead rounded, or with anterior margin flattened or slightly concave 7
   Species usually elongated; forehead long and narrow, with the anterior margin either emarginated or deeply notched 10
7. Abdominal spiracles present on segments ii to iv. On Viverridae ... ... *Suricatoecus*, p. 365.
   Abdominal spiracles present on segments ii to vii 8
8. Abdominal tergites with transverse median sclerites 9
   Abdominal tergites without transverse median sclerites; forehead very short and broad. On Canidae, etc. *Trichodectes*, p. 364.
9. Parameres of male genitalia forming a pseudopenis; small, slender species. On Procaviidae ... *Procaviphilus*, p. 360.
   Parameres of male genitalia not forming a pseudopenis. On Bovidae and Equidae ... ... *Bovicola*, p. 361.
10. Anterior margin of forehead with a deep U-shaped notch. On antelopes ... ... *Damalinia*, p. 364.
   Anterior margin of forehead emarginated. On antelopes *Tricholipeurus*, p. 363.

Genus Procavicola Bedford.

Procavicola Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

This genus comprises twelve species found on Procaviidae.

Genotype: *Trichodectes sternatus* Bedford.

1. **Procavicola emarginata** (Bedford).

Trichodectes emarginatus Bedford, *Repts. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 845, Pl. 2, f. 5 (1928).
Procavicola emarginata Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from a ♂ taken off *Heterohyrax ruddi* (Wr.) Zoutpansberg District, Transvaal. Males and females have also been taken off the same host, Macequece, Portuguese East Africa.

2. **Procavicola heterohyracis** Bedford.

Procavicola heterohyracis Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from males and females taken off *Heterohyrax granti* (Wr.) Blyda River, Mariepskop, northern Transvaal.

3. **Procavicola lindfieldi** (Hill).

Trichodectes lindfieldi Hill, *Parasit.*, XIV, p. 65, Pl. 2, f. 4-6 (1922).

Trichodectes lindfieldi (Hill) Bedford, *Repts. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 845 (1928).

Procavicola lindfieldi (Hill) Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described by Hill from specimens reported to have been taken off *Procavia capensis*, Ntabamhlope, Natal, but the host is probably a new species. Specimens have also been taken off *Heterohyrax ruddi* (Wr.), N'jelele River, Zoutpansberg District, Transvaal, and Macequece, Portuguese East Africa; *Heterohyrax granti* (Wr.), Blyda River, Mariepskop, Transvaal, and *Procavia natalensis* Rbts., Piggs Peak, Swaziland; Knysna and Kleinpoort, near Grahamstown, in the Cape Province, and Deepdale, Natal.

4. **Procavicola natalensis** Bedford.

Procavicola natalensis Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from specimens taken off *Procavia natalensis* Rbts., Piggs Peak, Swaziland; Deepdale, Natal; Knysna and Kleinpoort, near Grahamstown, Cape Province.

5. **Procavicola neumanni** (Stobbe).

Trichodectes univirgatus var. neumanni Stobbe, *Ent. Rundschau*, XXX, p. 112 (1913).

Trichodectes sternatus Ferris, *Rep. Harvard-Afr. Exped. Afr. Rep. Liberia and Belg. Congo*, ii, p. 1033, f. 21-22 (1930), *nec* Bedford, 1928.

Procavicola neumanni (Stobbe) Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Recorded by Stobbe from *Dendrohyrax sp.* in the Berlin Museum. I also refer the following to this species: Specimens recorded by Ferris (1930) from *Dendrohyrax adolfi-friederici*, Lulenga, Belgian Congo, and specimens from *Dendrohyrax arborea* (A. Sm.), Port St. Johns, C.P. (coll. G.A.H.B.).

6. **Procavicola parva** Bedford.

Procavicola parva Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from specimens taken off *Procavia sp.*, Lamberts Bay, C.P.

7. **Procavicola pretoriensis** Bedford.

Procavicola pretoriensis Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from specimens taken off *Procavia coombsi* Rbts., Onderstepoort, also from same host, Weltevreden, Parys, O.F.S.

8. **Procavicola sternata** (Bedford).

Trichodectes sternatus Bedford, *Repts. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 845, Pl. 4, f. 9; Pl. 5, f. 12 (1928).

Procavicola sternata Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from specimens reported to have been taken off *Procavia capensis*, Ntabamhlope, Natal, but the host is probably a new species.

9. **Procavicola subparva** Bedford.

Procavicola subparva Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from specimens taken off *Procavia sp.*, Mount Fletcher, Cape Province.

10. **Procavicola univirgata** (Neumann).

Trichodectes univergatus Neu., *Arch. de Parasit.*, XV, p. 612, f. 6 (1913).

Trichodectes univergatus (Neu.) Ferris, *Rep. Harvard-Afr. Exped. Afr. Repub. Liberia and Belg. Congo*, ii, p. 1030, f. 17-18 (1930).

Procavicola univirgata (Neu.) Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described by Neumann from specimens taken off *Hyrax sp.*, Congo. All dassies were formally placed in the genus *Hyrax*, which is a synonym of *Procavia*. Ferris (1930) recorded it from *Dendrohyrax adolfi-friederici*, Lulenga, Belgian Congo, and specimens have been taken off *Dendrohyrax arborea* (A. Smith), Port St. Johns, C.P. (coll. G.A.H.B.).

Genus Dasyonyx Bedford.

Dasyonyx Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

This genus comprises seven species found on Procaviidae.

Genotype: *Dasyonyx validus* Bedford.

1. **Dasyonyx oculatus** (Bedford).

Trichodectes oculatus Bedford, *Rep. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 847, Pl. 4, f. 10; Pl. 6, f. 14 (1928).

Dasyonyx oculatus Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from a ♂ taken off *Heterohyrax ruddi* (Wr.), Zoutpansberg District, Transvaal.

2. **Dasyonyx ovalis** Bedford.

Dasyonyx ovalis Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from males and females taken off *Procavia coombsi* Rbts., Weltevreden, Parys, O.F.S.

3. **Dasyonyx transvaalensis** Bedford.

Eutrichophilus diacanthus Bedford, *Repts. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 848, Pl. 2, f. 6 (1928), *nec* Ehrenberg, 1828.

Dasyonyx transvaalensis Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described by Bedford (1928) from a single female taken off *Procavia coombsi* Rbts., Rooikrans, Transvaal. Both sexes have been taken off the same host at Onderstepoort, and a female off *Heterohyrax granti* (Wr.), Blyda River, Mariepskop, northern Transvaal.

4. **Dasyonyx waterbergensis** Bedford.

Dasyonyx waterbergensis Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from males and females taken off *Procavia waterbergensis* Brauer, Otjiwarongo, South-West Africa.

Genus PROCAVIPHILUS Bedford.

This genus comprises five species found on Procaviidae (dassies).

Genotype: *Procaviphilus ferrisi* Bedford.

1. **Procaviphilus granulatus** (Ferris).

Trichodectes granulatus Ferris, *Rept. Harvard-Afr. Exped. Afr. Repub. Liberia and Belg. Congo*, ii, p. 1029, t.f. 16 A-D (1930).

Procaviphilus granulatus (Ferris) Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described by Ferris from a single female taken off *Dendrohyrax adolfi-friederici*, Lulenga, Belgian Congo. Three females taken off *Dendrohyrax arborea* (A. Smith), Port St. Johns, C.P. (coll. G.A.H.B.).

2. **Procaviphilus robertsi** (Bedford).

Trichodectes robertsi Bedford, *Rept. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 846, Pl. 1, f. 2 (1928).

Procaviphilus robertsi Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described in 1928 from a single male taken off *Heterohyrax ruddi* (Wr.), Zoutpansberg District, Transvaal. Both sexes have since been taken off the same host, N'jelele River, Zoutpansberg District, Transvaal, and Macequece, Portuguese East Africa.

3. **Procaviphilus sclerotis** Bedford.

Procaviphilus sclerotis Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Males and females taken off *Heterohyrax granti* (Wr.), Blyda River, Mariepskop, northern Transvaal.

4. **Procaviphilus serraticus** (Hill).

Trichodectes serraticus Hill, *Parastiology*, XIV, p. 67, Pl. 2, f. 7-9 (1922).

Procaviphilus serraticus (Hill) Bedford, *Proc. Zool. Soc. Lond.*, 1932 (in press).

Described from males and females taken off *Procavia capensis*, Mtabamhlope, Natal, but the host will probably prove to be a new species. A male recorded by Bedford (1928) from *Procavia coombsi* Rbts. may be *P. sclerotis* Bedf. Specimens have also been taken off *Procavia natalensis* Rbts., Knysna and Grahamstown, Cape Province; also off *Procavia sp.*, Lamberts Bay, C.P.

Genus Bovicola Ewing.

Bovicola Ewing, Manual of Ext. Parasit., pp. 123, 193 (1929).

Bovidoecus Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 518 (Oct., 1929).

This genus contains several species parasitic on Bovidae and Equidae.

Genotype: *Trichodectes caprae* Gurlt.

1. **Bovicola bovis** (Linnaeus).

Pediculus bovis Linnaeus, *Syst. Nat.*, p. 611 (1758).

Trichodectes scalaris Nitzsch, in Burmeister, *Handbuch*, II, p. 436 (1838).

Trichodectes scalaris (N.) Piaget, *Pédiculines*, p. 396, Pl. 33, f. 2 (1880).

The females of this species are common on cattle in South Africa, but the males are extremely rare. Bedford has figured the ♂ genitalia (1920, Pl. 6, f. 3).

2. **Bovicola caprae** (Gurlt).

Trichodectes caprae Gurlt, *Mag. f. ges. Tierheilk*, IX, p. 3, Pl. 1, f. 2 (1843).

T. climax Nitzsch, in Gervais, *Hist. Ins. Apt.*, III, p. 313, Pl. 48, f. 3 (1847).

T. solidus Rudow, *Zeit. f. ges. Nat.*, XXVII, p. 112, Pl. 7, f. 2 (1866).

T. climax (N.) Piaget, *Pédiculines*, p. 391, Pl. 32, f. 1 (1880).

Both females and males are common on goats in South Africa. Bedford has figured the ♂ genitalia (1920, Pl. 6, f. 1).

3. **Bovicola equi** (Linnaeus).

Pediculus equi Linnaeus, *Syst. Nat.*, p. 612 (1758).

Trichodectes parumpilosus Piaget, *Pédiculines*, p. 397, Pl. 32, f. 5 (1880).

The females are common on domestic equines in South Africa, but I have not seen a male.

4. **Bovicola harrisoni** (Cummings).

Trichodectes harrisoni Cumms., *Proc. Zool. Soc. Lond.*, p. 276, f. 13-16 (1916).

Described from males and females taken off *Connochaetes gnu* (white-tailed gnu), Zoological Gardens, London. Specimens have been taken off the same host at Clocolan, O.F.S.

5. **Bovicola limbatus** (Gervais).

Trichodectes limbatus Gervais, *Hist. Ins. Apt.*, III, p. 313, Pl. 48, f. 4 (1847).

T. crassipes Rudow, *Zeit. f. ges. Nat.*, XXVII, p. 3, Pl. 7, f. 1 (1866).

T. pennicillatus Piaget, *Pédiculines*, p. 406, Pl. 32, f. 10 (1880).

T. climax var. major, Piaget, *Pédiculines*, Suppl., p. 86 (1885).

T. hermsi Kellogg & Makayama, *Psyche*, XXII, p. 34 (1915).

Both sexes of this species are common on Angora goats in South Africa.

6. **Bovicola ocellata** (Piaget).

Trichodectes parumpilosus var. ocellata Piaget, *Pédiculines*, p. 398 (1880).

Described from specimens taken off the zebra, *Hippotigris burchelli*.

7. **Bovicola ovis** (Linnaeus).

Pediculus ovis Linnaeus, *Syst. Nat.*, p. 611 (1758).

Pediculus sphaerocephalus von Olfers, *De Veget. et. Anim. Corpor. in Anim. Reper. Comm.*, p. 85 (1816).

Trichodectes sphaerocephalus Piaget, *Pédicul.*, p. 393, Pl. 32, f. 2 (1880).

Both sexes of this species have been found on sheep in South Africa, but they are not very common.

8. **Bovicola painei** (Kellogg and Nakayama).

Trichodectes painei Kell. & Nak., *Psyche*, XXI, p. 90, f. 1 (1914).

Both sexes are common on goats in South Africa. The ♂ differs from that of *B. caprae* in having the posterior margin of the second tergite broadly emarginated in the middle. The ♂ genitalia, figured by Bedford (1920, Pl. 6, f. 2) are also different.

9. **Bovicola peregrina** (Taschenberg).

Trichodectes peregrinus Tasch., *Nova Acta*, XLIV, p. 218, Pl. 7, f. 10 (1882).

Ferris (1916, p. 251) records it from fat-tailed sheep, South-West Africa. It was described from specimens taken off *Mycteria crumenifera* in the Zoological Gardens, Hamburg.

Genus TRICHOLIPEURUS Bedford.

Tricholipeurus Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 514 (1929).

This genus comprises several species found on antelopes and deer.

Genotype: *Tricholipeurus aepycerus* Bedford.

1. **Tricholipeurus aepycerus** Bedford.

T. aepycerus Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 515, f. 14, 15, 18 (1929).

Described from a ♂ and ♀ taken off *Aepyceros melampus* (impala), Kunene River, South-west Africa, but the host was probably *A. petersi* (Angola impala). A new species has been found on *A. melampus*.

2. **Tricholipeurus antidorcus** Bedford.

T. antidorcus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVII, p. 283, f. 1-3 (1931).

Described from males and females taken off *Antidorcas marsupialis* at Onderstepoort.

3. **Tricholipeurus bedfordi** (Hill).

Trichodectes bedfordi Hill, *Parasit.*, XIV, i, p. 63, Pl. 2, f. 1-3 (1922).

Described from numerous males and females taken off *Philantomba (Cephalophus) monticola* (blue duiker), Ngome Forest, Mt. Ngwibi, Natal.

4. **Tricholipeurus lerouxi** Bedford.

L. lerouxi Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVI, p. 163, f. 7 (1930).

Described from two females taken off *Sylvicapra grimmi* (duiker) near the Umfolosi River, Zululand.

5. **Tricholipeurus lineatus** (Bedford).

Trichodectes lineatus, Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 723, Pl. 5, f. 2 (1920).

Described from specimens taken off *Raphiceros campestris* (steenbuck) in the Rustenburg District, Transvaal.

6. **Tricholipeurus reduncae** Bedford.

T. reduncae Bedford, *Ann. Rep. Dir. Vet. Res., Un. S. Afr.*, XV, p. 517, f. 16, 17, 17b (1929).

Described from males and females taken off *Redunca arundinum* (reedbuck) at Emakosini, N. Zululand. They were recorded under the name of *Trichodectes cornutus* Gervais in the first edition.

7. **Tricholipeurus trabeculae** Bedford.

T. trabeculae Bedford, *Ann. Rep. Dir. Vet. Res., Un. S. Afr.*, XV, p. 516, f. 17a, 17c, 19 (1929).

Described from males and females taken off *Redunca fulvorufula* (mountain reedbuck), Mfongosi, Zululand. They were erroneously recorded by Ferris (1916a) and Bedford (1919) under the name of *Trichodectes cornutus* Gervais.

Genus Damalinia Mjöberg.

Damalinia Mjöberg, *Arkiv. f. Zoologi*, VI, p. 69 (1910).

This genus includes two species found on antelopes.

Genotype: *Trichodectes crenelatus* Piaget.

1. **Damalinia crenelata** (Piaget).

Trichodectes crenelatus Piaget, *Pédiculines*, p. 402, Pl. 32, f. 8 (1880).

Described from specimens taken off blesbok, *Damaliscus albifrons (= Antilope albifrons)*. Specimens have also been taken off the same host from the Pretoria District at Onderstepoort, and one immature male from *Damaliscus dorcas* (bontebok), Bredasdorp, C.P. (coll. R. F. Lawrence).

2. **Damalinia theileri** Bedford.

Damalinia theileri Bedford, *Repts. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 849, Pl. 6, f. 15, Pl. 7, f. 16 (1928).

Described from a female taken off blue wildebeest (*Gorgon taurinus*) in the Zoutpansberg District, northern Transvaal. Both sexes have since been taken off the same host in the Pretoria Zoo (coll. G.A.H.B.).

Genus Trichodectes Nitzsch.

Trichodectes Nitzsch, *Germar's Magazin*, III, p. 294 (1818).

Until recently the majority of the species belonging to the family Trichodectidae were placed in this genus. It should probably only include species parasitic on carnivores belonging to the families Canidae, Procyonidae, and possibly also the Mustelidae.

Genotype: *Ricinus canis* De Geer.

1. **Trichodectes canis** (De Geer).

Ricinus canis De Geer, *Mem. d'hist. Ins.*, VII, p. 81, Pl. 4, f. 16 (1778).

Trichodectes latus Nitzsch, in Burmeister, *Hand. der Ent.*, p. 436 (1838).

Trichodectes latus (Nitz.) Piaget, *Pédiculines*, p. 384, Pl. 31, f. 6 (1880).

This species has been recorded taken off domestic dogs in Europe, America and Australia, but has so far not been recorded from these animals in Africa.

2. **Trichodectes ovalis** Bedford.

Trichodectes ovalis Bedford, *Repts. Dir. Vet. Educ. & Res., Un. of S. Afr.*, XIII-XIV, p. 841, Pl. 1, f. 1, 3; Pl. 6, f. 13 (1928).

Trichodectes ovalis Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from males and females taken off *Poecilogale albinucha* at Onderstepoort. Bedford (1929) also recorded it from *Ictonyx striatus* in South-West Africa and Natal.

3. **Trichodestes vosseleri** Stobbe.

Trichodectes vosseleri Stobbe, *Sitz.-Ber. Ges. nat. Freunde*, VIII, p. 371, f. 2 (1913).

Described from a male and female taken off *Potamochoerus demunis*, Tanganyika Territory. Specimens have also been taken off *Mellivora capensis* (ratel), Knysna, C.P., and Kleinpoort, Albany District, C.P. There can be no doubt that either an error was made in recording the host of the types, or the specimens were stragglers.

Genus Suricatoecus Bedford.

Suricatoecus Bedford, *Parasit.*, XXIV, 1932 (in press).

Only the following species is included in this genus.

1. **Suricatoecus cooleyi** (Bedford).

Trichodectes cooleyi Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 513, f. 13 (1929).

Suricatoecus cooleyi Bedford, *Parasit.*, 1932 (in press).

Described from males and females taken off *Suricata suricatta hamiltoni* in the Pretoria District, Transvaal.

Genus Protelicola Bedford.

Protelicola Bedford, *Parasit.*, XXIV, 1932 (in press).

Only the following species is included in this genus:—

1. **Protelicola intermedia** Bedford.

Protelicola intermedia Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from males and females taken off *Proteles cristatus* (aardwolf), Umkomaas Valley, Natal.

Genus Felicola Ewing.

Felicola Ewing, A Manual of External Parasites, pp. 122, 192 (1929).

Felicinia Bedford, *Ann. Rept. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 519 (1929).

Felicola Bedford, *Parasit.*, XXIV, 1932 (in press).

This genus includes a number of species parasitic on Felidae and Viverridae. For key to the African species see Bedford (1932).

Genotype: *Trichodectes subrostrata* Nitzsch.

1. **Felicola acutirostris** (Stobbe).

Trichodectes acutirostris Stobbe, *Sitz.-Ber. Ges. nat. Freunde*, VIII, p. 378, f. 7 (1913).

Felicola acutirostris (Stobbe) Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from specimens taken off water mongoose, *Atilax paludinosus (= Herpestes galera)*, Pemba. Specimens have also been taken off the same host, Vredendal, Olifants River.

2. **Felicola caffra** (Bedford).

Trichodectes caffra Bedford, *Repts. Dir. Vet. Res., Un. S. Afr.*, V-VI, p. 724, Pl. 3, f. 10, 11 (1919).

Felicola caffra Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from a male and female taken off *Felis ocreata caffra* (Cape wild cat), Blockspruit, Rustenburg District, Transvaal.

3. **Felicola calogalea** (Bedford).

Trichodectes calogaleus Bedford, *Repts. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 843, Pl. 2, f. 4; Pl. 3, f. 7 (1928).

Felicola calogalea Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from males and females taken off slender mongoose, *Myonax cauui (= Calogale cauui)* in the Rustenburg District, Transvaal, and from *M. pulverulentus (= Calogale pulverulentus)*, Kenkelbosch, C.P. Specimens have also been taken off *Myonax nigratus*, Otjitundua, Kaokoveld, South-West Africa.

4. **Felicola cynictis** (Bedford).

Trichodectes cynictis Bedford, *Repts. Dir. Vet. Educ. & Res., Un. S. Afr.*, XIII-XIV, p. 844, Pl. 3, f. 8 (1928).

Felicola cynictis Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from males and females taken off *Cynictis penicillata* (yellow mongoose), Onderstepoort, Transvaal, and Bothaville, O.F.S.

5. **Felicola genetta** (Bedford).

Trichodectes genetta Bedford, *Repts. Dir. Vet. Res., Un. S. Afr.*, V-VI, p. 725, Pl. 4, f. 12-13 (1919).

Felicola genetta Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from a male and two immature females taken off *Genetta felina ludia* (Transvaal small-spotted genet), Jericho, Transvaal. Females, which I take to be the same, have been taken off *Genetta tigrina* (large-spotted genet), Pietermaritzburg, Natal.

6. **Felicola helogale** Bedford.

Felicola helogale Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from two females and one immature male taken off *Helogale parvula brunnula* (pigmy mongoose), N'jelele River, northern Transvaal.

7. **Felicola rammei** (Stobbe).

Trichodectes rammei Stobbe, *Sitz.-Ber. Ges. nat. Freunde*, VIII, p. 377, f. 6 (1913).

Felicola rammei (Stobbe) Bedford, *Parasit.*, XXIV, 1932 (in press).

Described by Stobbe from specimens taken off water mongoose, *Atilax paludinosus (= Herpestes galera)*, Tanganyika Territory. They were possibly stragglers, or the host may have been misidentified. Specimens which I regard as probably this species have been taken off *Herpestes caffer* (Cape ichneumon), Pietermaritzburg, Natal, and Ferris (1930) records numerous specimens he considers to be this species from *Galerella brunneo-ochraeea*, Belgian Congo.

8. **Felicola rostrata** Bedford.

Felicola rostrata Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from numerous specimens taken off *Ichneumia albicauda* (white-tailed mongoose), Umfolosi River, Zululand.

9. **Felicola setosa** Bedford.

Felicola setosa Bedford, *Parasit.*, XXIV, 1932 (in press).

Described from males and females taken off *Paracynictis selousi* (Selous' mongoose), Mokeetsi, Transvaal.

10. **Felicola subrostrata** (Nitzsch).

Trichodectes subrostratus Nitz., in Burmeister, *Handb. der Ent.*, II, p. 436 (1838).

Trichodectes subrostratus (Nitz.) Piaget, *Pédiculines*, p. 389, Pl. 31, f. 9 (1880).

Felicola subrostrata (Nitz.) Bedford, *Parasit.*, XXIV, 1932 (in press).

Recorded by Bedford (1920) taken off domestic cat, Pietermaritzburg, Natal.

Superfamily AMBLYCERA.

The majority of the species belonging to this superfamily are very active and may be found running about on the bodies of their hosts. One or two species have been found living in the quills of the wing-feathers of birds. The species of Gyropidae infesting guinea-pigs are found attached to the hairs of their hosts.

Key to the South African Families.

1. Tarsi of all the legs with two claws 2

Tarsi of mid and hind legs either with a single claw or clawless. On guinea-pigs ... ... *Gyropidae*, p. 394.

2. Antennae lying in grooves at the sides of the head; abdomen constricted at the junction of the thorax and the different segments .. .. *Menoponidae.*
   Antennae situated in capsules which open ventrally; abdomen not conspicuously constricted at the junction of the thorax and the different segments 3
3. The lateral margins of forehead swollen, the ocular emarginations therefore distinct, labrum without protrusible membranous flap ... ... *Laemobothriidae*, p. 395.
   The lateral margins of forehead not swollen, the ocular emarginations therefore indistinct or absent; labrum usually with membranous flap projecting beyond lateral margin of forehead ... ... *Ricinidae*, p. 397.

Family MENOPONIDAE Mjöberg.

Key to the South African Subfamilies and Genera.

1. Antennae usually 4-jointed, rarely 3 or 5-jointed; setae of thorax seldom spine-like; ♂ genitalia without accessory sac. On birds (subfamily *Menoponinae*) 2
   Antennae 5-jointed; some of the setae, especially on thorax, spine-like; ♂ genitalia with accessory sac. On Australian marsupials and dog. (Subfamily *Boopinae*) *Heterodoxus*, p. 394.
2. Venter of hind femora and sternites without combs of spines, but patches of setae are frequently present 3
   Venter of hind femora and sternites iii or iii and iv with combs of minute spines 23
3. Ocular emarginations either shallow or absent; forehead without a notch in front of the eyes, but a slit is often present 4
   Ocular emarginations deep 18
4. Temples with lateral margins rounded 5
   Temples angulate; ocular emarginations absent; prothorax as large as the head. On fulmar and petrels *Ancistrona*, p. 371.
5. Forehead with a pair of large spine-like processes situated on venter beneath bases of palpi (two pairs may be present in *Menacanthus* (sens. lato) 6
   Forehead without such processes 8
6. Oesophageal glands present (absent in *numidae*); tergites with one or two rows of setae. On Galliformes *Neumannia*, p. 378.
   Oesophageal glands absent 7
7. Species elongate; forehead narrow in front; tergites with two rows of setae. On Galliformes ... *Eomenacanthus*, p. 378.
   Species broader; forehead broadly rounded in front; tergites with one or two rows of setae .., *Menacanthus*, p. 378.
8. Gular region of head with a well-developed gular plate 9
   Gular region without a plate, or if present faintly indicated 10

9. Gular plate trilobed, the median lobe the largest. On rails, grebes and painted snipe ... ... *Pseudomenopon*, p. 377.
   Gular plate squarish, with one or two pairs of lateral spine-like processes ... ... *Machaerilaemus*, p. 377.

10. Antennae elongated, the apical joint long and slender, about as long as, or longer than, the two penultimate joints together; ocular emarginations indistinct; on Galliformes 11
    Antennae not elongated, the apical joint short and broad ... 13

11. Forehead without a slit in front of the eyes. On Numididae ... 12
    Forehead with a slit in front of the eyes *Menopon* (sens. str.), p. 372.

12. Species long and slender; prothorax less than twice as wide as long; tergites with numerous setae *Somaphantus*, p. 371.
    Species not long and slender; prothorax more than twice as wide as long; tergites with a single row of setae *Numidicola*, p. 371.

13. Forehead with a slit in front of the eyes; meso and meta-notum fused 14
    Forehead without a slit; meso and meta-notum divided by a suture 15

14. ♂ genitalia with basal plate short and broad; endomeral plate with backward projecting curved hooks on each side; oesophageal sclerite and glands absent. On hornbills ... ... *Allomenopon*, p. 376.
    ♂ genitalia otherwise... ... ... *Menopon (sens. lato)*, p. 372.

15. Head more than twice as broad as long 16
    Head less than twice as broad as long 17

16. Eyes present; posterior margin of temples with a backward projecting process; venter of hind femora and sternites v-vii with patches of closely set setae. On swift *Eureum*, p. 380.
    Eyes absent; temples rounded, without processes; hind femora and sternites without patches of setae. On Hirundinidae *Hirundoecus*, p. 380.

17. Anterior femora dilated, about as broad as, or broader than, long; sternite ii without asters of spines; oesophageal sclerite small or absent. On swifts ... *Dennyus*, p. 380.
    Anterior femora longer than broad; sternite ii usually, but not always, with asters of heavy spines. Metanotum or tergite i of ♀♀ sometimes produced posteriorly; oesophageal sclerite present. Mainly on passerines *Myrsidea*, p. 381.

18. Forehead without a slit or notch in front of the eyes 19
    Forehead with a notch in front of the eyes 21

19. Forehead very broad in front; ocular emarginations very deep, the posterior margins of forehead straight, meeting the temples at right angles. On sandgrouse *Neomenopon*, p. 382.

Forehead narrow in front; ocular emarginations not so deep ... 20

20. Thorax very large, the mesonotum unusually so; femora and tibiae short, dilated; basal plate of ♂ genitalia elongated, rod-like. On Anatidae and Phoenicopteridae *Trinoton*, p. 382.

Thorax not abnormally large; the mesonotum small; femora and tibiae long and narrow; basal plate of ♂ genitalia large and broad. On hornbills .. ... *Chapinia*, p. 384.

21. Abdomen with a narrow transverse chitinous sclerite on each segment, except the last, indistinct on segments iv-viii. On spoonbill ... ... *Eucolpocephalum*, p. 384.

Abdomen without narrow transverse chitinous sclerites on the segments 22

22. Venter of hind femora and sternite iv with brushes of setae, the setae shorter than those of the general chaetotaxy of the sternites. On cranes ... ..., *Heleonomus*, p. 384.

Venter of hind femora and certain sternites with brushes of setae which are as long as those of the general chaetotaxy. On Charadriiformes ... ... *Actornithophilus*, p. 385.

23. Forehead with a slit in front of the eyes 24

Forehead with a notch in front of the eyes 25

24. Combs present on sternite iii only; prothoracic spiracles absent; abdominal spiracles small, without setae on their posterior margins; mandibles one or two-toothed; tibiae of ♂ without a thumb-like spur at their apices; basal plate of ♂ genitalia, long, rod-like. On parrots *Psittacomenopon*, p. 387.

Combs present on sternites iii and iv; prothoracic spiracles present; abdominal spiracles large, with small setae on their posterior margins; mandibles two or three-toothed; tibiae of ♂ with a thumb-like spur at their apices; basal plate long, rod-like. On pelicans ... ... *Tetrophthalmus*, p. 387.

25. Combs present on third and fourth sternites; sexes not dimorphic. On Cuculiformes, Coraciiformes, and Strigiformes ... ... *Cuculiphilus*, p. 388.

Combs present on third sternite only 26

26. Abdomen similar in both sexes 27

Abdomen dimorphic in both sexes *Colpocephalum* (sens str.), p. 388.

27. On Falconiformes ... ... *Kurodaia*, p. 388.

Not on Falconiformes ... *Colpocephalum* (sens lato), p. 388.

Subfamily MENOPONINAE.

Genus Ancistrona Westwood.

Ancistrona Westwood, *Thes. Ent. Oxon.*, p. 197 (1874).

This genus includes but a single species.

1. **Ancistrona vagelli** (Fabricius).

Pediculus vagelli Fabr., *Mant. Ins.*, p. 369 (1787).

Ancistrona procellariae Westw., *Thes. Ent. Oxon.*, p. 197, Pl. 37, f. 4 (1874).

Ancistrona gigas Piaget, *Tijd. v. Ent.*, XXVI, p. 152, Pl. 9, f. 1 (1883).

Ancistrona gigas, Piaget, *Pédicul.*, Suppl., p. 117, Pl. 12, f. 8 (1885).

Recorded by Waterston (1914) taken off *Oceanites oceanicus* (sooty petrel) in the Cape Province. Westwood (1874) described it from specimens taken off *Daption capensis* (Cape sea-pigeon). Kellogg (1914) recorded it from brown petrel, *Pterordroma incerta (= Oestrelata incerta)* and soft-plumaged petrel, *Pterodroma mollis* in the South Atlantic. Both these birds occur on the South African coast. Specimens have been taken off *Neonectris griseus* (sooty shearwater), Capetown, C.P. (coll. R. F. Lawrence).

Genus Somaphantus Paine.

Somaphantus Paine, *Smithsonian Misc. Coll.*, LXI, No. 23, p. 1 (1914).

This genus has not yet been recorded from South Africa, but will probably be found on guinea-fowls. It includes a single species, *S. lusius* Paine, found on *Numida ptilorhyncha*.

Genus Numidicola Ewing.

Numidicola Ewing, *Journ. Wash. Acad. Sci.*, XVII, iv, p. 90 (1927).

This genus includes two species found on guinea-fowls.

Genotype: *Numidicola longicornis* Ewing.

1. **Numidicola antennata** (Kellogg and Paine).

Menopon antennatum Kell. & Paine, *Bull. Ent. Res.* II, p. 150, Pl. 5, f. 1 (1911).

Described from specimens taken off *Numida mitrata* in the Sudan. Bedford (1919) recorded it from *Numida coronata* in the Transvaal and from a guinea-fowl in Natal. The skin of the former is in the Transvaal Museum and proves to be *Numida papillosa transvaalensis*.

Genus Menopon Nitzsch.

Menopon Nitzsch, *Germar's Magazin*, III, p. 299 (1818)

This genus, which will have to be split up, comprises at present about a hundred and eighty species.

Genotype: *Pediculus gallinae* Linné.

1. **Menopon albidum** Giebel.

Menopon albidum Giebel, *Ins. Epiz.*, p. 280 (1874).

Described from specimens taken off *Neophron percnopterus* (Egyptian vulture).

2. **Menopon albipes** Giebel.

Menopon albipes Giebel, *Zeit. f. ges. Nat.*, XLVII, p. 250 (1876).

Described from specimens taken off white-crowned wattled plover, *Xiphidiopterus albiceps (= Lobivanellus albiceps).*

3. **Menopon ambiguum** Nitzsch.

Menopon ambiguum Nitzsch, in Giebel, *Ins. Epiz.*, p. 295 (1874).

Described from specimens taken off whimbrel, *Phaeopus phaeopus (= Numenius phaeopus)*, a migrant to South Africa.

4. **Menopon brevipalpe** Piaget.

Menopon brevipalpe Piaget, *Pédiculines*, p. 498, Pl. 40, f. 5 (1880).

Recorded by Waterston (1914) taken off Cape cormorant, *Pseudocarbo capensis (= Phalacrocorax capensis)* in South Africa. Piaget described it from specimens taken off *Phalacrocorax carbo.*

5 **Menopon circinatum** Piaget.

Menopon circinatum Piaget, *Tijd. v. Ent.*, XXXIII, p. 249, Pl. 10, f. 4 (1888).

Described from specimens taken of large white-necked skua, *Coprotheres pomarinus (= Stercorarius pomarinus).*

6. **Menopon coarctatum** (Scopoli).

Pediculus coarctatus Scopoli, *Ent. Carn.*, p. 382 (1763).

Pediculus collurionis Schrank, *Fauna Boica*, p. 187 (1803).

Menopon fuscocinctum Denny, *Anoplur. Brit.*, p. 219, Pl. 21, f. 4 (1842).

Menopon camelinum Nitzsch in Giebel, *Ins. Epiz.*, p. 288, Pl. 15, f. 3 (1874).

Described by Scopoli, Schrank and Denny from specimens taken off red-backed shrike, *Enneoctonus collurio (=Lanius collurio)*, a migrant to South Africa.

7. **Menopon crocatum** Nitzsch.

Menopon crocatum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 392 (1866).

Menopon crocatum (Nitz.) Giebel, *Ins. Epiz.*, p. 295 (1874).

Described from specimens taken off *Numenius arquatus* (curlew), a migrant to South Africa.

8. **Menopon eulasium** Kellogg.

Menopon eulasium Kellogg, *Schwed. Exp. Kilimanjaro*, p. 54, Pl. 7. f. 11 (1910).

Described from specimens taken off reed cormorant, *Microcorax africana (= Phalacrocorax africanus)* in East Africa.

9. **Menopon exile** Nitzsch.

Menopon exile Nitzsch, *Zeit f. ges. Nat.*, XXVII, p. 121 (1866).

Described from specimens taken off European wheatear, *Oenanthe oenanthe (= Saxicola oenanthe)*, a migrant to South Africa.

10. **Menopon francolinus** Bedford.

Menopon francolinus Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII and VIII, p. 712, Pl. 2, f. 2: Pl. 5, f. 1 (1920).

Described from specimens taken off bush partridge, *Dendroperdix sephaena (= Francolinus sephaena)*, and Swainson's red-necked francolin, *Pternistis swainsoni* in the Transvaal.

11. **Menopon fuscofasciatum** Piaget.

M. fuscofasciatum Piaget, *Pédiculines*, p. 492, Pl. 40, f. 9 (1880).

Described from specimens taken off large white-necked skua, *Coprotheres pomarinus (= Lestris pomarina)*. Piaget (1880) also recorded it from sandwich tern, *Thalasseus sandvicensis (= Sterna cantiaca)*.

12. **Menopon gallinae** (Linnaeus), Fig. 14A.

Pediculus gallinae Linné, *Syst. Nat.*, p. 613 (1758).

Menopon pallidum Nitzsch, in Burmeister, *Handbuch*, II, p. 440 (1838).

Menopon gallinae (L.) Ferris, *Parasit.*, XVI, i, p. 57, f. 1 A-D (1924).

A common parasite of the domestic fowl in South Africa.

13. **Menopon inaequale** Piaget.

Menopon inaequale Piaget, *Pédiculines*, p. 443, Pl. 35, f. 1 (1880).

Described from specimens taken off red-backed shrike, *Enneoctonus collurio (= Lanius collurio)*, a migrant to South Africa. It is probably a synonym of *M. cœrctatum* (Scopoli).

14. **Menopon intermedium** Piaget.

Menopon intermedium Piaget, *Pédiculines*, p. 497, Pl. 40, f. 4 (1880).

Described from specimens taken off frigate bird, *Fregata minor (=Atagen minor).*

15. **Menopon lutescens** Nitzsch.

Menopon lutescens Nitz., in Burmeister, *Handbuch*, II, p. 440 (1838).

Menopon lutescens (N.) Piaget, *Pédiculines*, p. 477, Pl. 39, f. 4 (1880).

Specimens have been taken off the ruff, *Philomachus pugnax* at Onderstepoort (coll. G.A.H.B.). It was described from specimens taken off *P. pugnax (=Machetes pugnax)* and other Charadriiformes.

16. **Menopon madagascariense** Mjöberg.

M. madagascariense Mjöberg, *Arkiv. f. Zool.*, VI, p. 34, f. 22 (1910).

Recorded by Bedford (1919) taken off *Scopus umbretta bannermani* (hammerhead) in the Transvaal and Natal. It was described from specimens taken off *Scopus umbretta* in Madagascar.

17. **Menopon meyeri** Giebel.

Menopon meyeri Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 392 (1866).

Menopon meyeri Giebel, *Ins. Epiz.*, p. 296 (1874).

Described from specimens taken off bar-tailed godwit, *Vetola lapponica (= Limosa rufa)*, a migrant to South Africa.

18. **Menopon micrandum** Nitzsch.

Menopon micrandum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 392 (1866).

Menopon micrandum (N.) Giebel, *Ins. Epiz.*, p. 295 (1874).

Described from specimens taken off *Recurvirostra avosetta* (avocet), a migrant to South Africa.

19. **Menopon nigropleurum** Denny.

N. nigropleurum Denny, *Anoplur. Brit.*, p. 224, Pl. 20, f. 1 (1842).

Described from specimens taken off the ruff, *Philomachus pugnax (= Machetes pugnax);* redshank, *Totanus totanus (= T. calidris), and curlew (Numenius arquata).* All these hosts are migrants to South Africa.

20. **Menopon pachyus** Piaget.

Menopon pachyus Piaget, *Tijd. v. Ent.*, *XXXIII*, p. 161, Pl. 4, f. 4 (1888).

Described from specimens taken off *Sterna hirundo* (common tern).

21. **Menopon parvulum** Piaget.

Monopon parvulum Piaget, *Pédiculines*, p. 444, Pl. 35, f. 4 (1880).

Described from specimens taken off European swift, *Micropus apus (= Cypselus apus)*, a migrant to South Africa.

22. **Menopon pellucidum** Rudow.

Menopon pellucidum Rudow, *Zeit. f. ges. Nat.*, XXXIV, p. 400 (1869).

Described from specimens taken off Cape cormorant, *Pseudocarbo capensis (= Phalacrocorax capensis)*.

23. **Menopon phaeostomum** Nitzsch.

M. phaeostomum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 391 (1866).

M. phaeostomum (N.) Piaget, *Pédiculines*, p. 466, Pl. 38, f. 1 (1880).

Recorded by Waterston (1914) taken off the type host, *Pavo cristatus* (peacock) in South Africa.

24. **Menopon powelli** Bedford.

Menopon powelli Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII-VIII, p. 714, Pl. 2, f. 1 (1920).

Described from specimens taken off *Pternistis swainsoni* (Swainson's red-necked francolin) and bush partridge, *Dendroperdix sephaena (= Francolinus sephaena)* in the Rustenburg District, Transvaal. Bedford (1929) also recorded it from *Chaetopus adspersus* (red-billed noisy francolin) and *Pternistis afer* (Angola red-necked francolin) on the Kunene River, South-West Africa. A ♀ has also been taken off *Pternistis castaneiventer krebsi* (Drakensberg red-necked francolin), in the Zoological Gardens, Pretoria (coll. G.A.H.B.).

25 **Menopon pustulosum** Nitzsch.

Menopon pustulosum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 393 (1866).

Menopon pustulosum (N.) Piaget, *Pédiculines*, p. 490, Pl. 41, f. 3 (1880).

Recorded by Waterston (1914) taken off malagas, *Sulita capensis (= Sula capensis)* in South Africa. The type host is *Sula alba*.

26 **Menopon sigmoidale** Picaglia.

Menopon sigmoidale Picaglia, *Atti. Soc. Ital. Sc. Nat.*, XXVIII, p. 6 (1885).

Described from specimens taken off *Phalacrocorax lucidus* (South African cormorant).

27 **Menopon strepsilae** Denny.

Menopon strepsilae Denny, *Anoplur. Brit.*, p. 226, Pl. 21, f. 8 (1842).

Described from specimens taken off a turnstone, *Arenaria interpres (= Strepsilas collaris)*, a migrant to South Africa.

28. **Menopon tumidum** Piaget.

M. tumidum Piaget, *Pédiculines, Suppl.*, p. 151, Pl. 16, f. 5 (1885).

M. africanum Kell. & Paine, *Bull. Ent. Res.*, II, p. 149, Pl. 5, f. 3 (1911).

M. africanum transvaalensis Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 716 (1920).

Recorded by Bedford (1920) taken off the following hosts in the Transvaal: *Plectropterus gambensis* (spur-winged goose); *Sarkidiornis melanotus africanus* (knob-billed duck); *Dendrocygna viduata* (white-faced duck), *Casarca cana* (South African shelduck); red-billed duck, *Paecilonitta erythrorhyncha (=Anas erythrorhyncha)*, and domestic ducks. Also recorded by Bedford (1929) from *Alopochen aegyptiacus* (Egyptian goose), Tamanzu, South-West Africa.

29. **Menopon virgo** Giebel.

Menopen virgo Giebel, *Ins. Epiz.*, p. 288 (1874).

Described from specimens taken off *Coracias garrulus* (European roller), a migrant to South Africa.

Genus Allomenopon Bedford.

Allomenopon Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVI, p. 153 (1930).

The species included in this genus are parasitic on hornbills.

Genotype: *Menopon bucerotis* Kellogg.

1. **Allomenopon bucerotis** (Kellogg).

Menopon bucerotis Kell., *Schwed. Exp. Kilimanjaro*, p. 54, Pl. 7, f. 12 (1910).

Menopon bucerotis (Kell.) Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 717, Pl. 3, f. 2 (1920).

Described from specimens taken off crested hornbill, *Baryrhynchus cristatus (= Bycanistes cristatus)* in East Africa. Bedford (1920) recorded specimens from *Bycanistes bucinator* (trumpeter hornbill) in Natal.

2. **Allomenopon lophocerum** (Bedford).

Menopon lophocerus Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 717, Pl. 1, f. 1; Pl. 3, f. 1 (1920).

Described from specimens taken off the following hosts in the Rustenburg District, Transvaal: South African grey hornbill *(Lophoceros epirhinus)*; southern red-billed hornbill, *Tockus erythrorhynchus rufirostris (= Lophoceros erythrorhynchus)*, and yellow-billed hornbill, *Xanthorhynchus leucomelas (= L. leucomelas)*.

Genus PSEUDOMENOPON Mjöberg.

Pseudomenopon Mjöberg, *Arkiv. f. Zool.*, VI, p. 50 (1910).

This genus comprises a few species parasitic on rails, grebes and painted snipe.

Genotype: *Menopon tridens* Nitzsch.

1. **Pseudomenopon rostratulae** Bedford.

Pseudomenopon rostratula Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, V & VI, p. 722, Pl. 2, f. 9 (1919).

Described from several females and males taken off painted snipe, *Rostratula benghalensis (= R. capensis)* in the Rustenburg District, Transvaal. Bedford (1929) also recorded two females taken off the same host in South-West Africa.

2. **Pseudomenopon tridens** (Nitzsch).

Menopon tridens Nitzsch, in Burmeister, *Handbuch*, II, p. 440 (1838).

Menopon scopulacorne Denny, *Anoplur. Brit.*, p. 221, Pl. 18, f. 9 (1842).

Menopon tridens pacificum Kell., *New Mallophaga*, I, p. 116 (1896).

Pseudomenopon tridens (N.) Ferris, *Parasit.*, XVI, I, p. 63, f. 4, A-F (1924).

Recorded by Bedford (1919) taken off the following hosts in the Rustenburg District, Transvaal: African moorhen *(Gallinula chloropus brachyptera)*; lesser moorhen, *Porphyriops angulata (= Gallinula angulata)*, and knob-billed coot, *Lupha cristata (= Fulica cristata)*. This species also occurs on *G. chloropus* and other rails in both Europe and America.

Genus MACHAERILAEMUS Harrison.

Machaerilaemus Harrison, *Parasit.*, VII, p. 389 (1915).

This genus includes four species found on passerines.

Genotype: *Machaerilaemus latifrons* Harrison.

1. **Machaerilaemus plocei** Bedford.

Machaerilaemus plocei Bedford, *Parasit.*, XII, ii, p. 168, Pl. 12, f. 1-3 (1920).

Described from a female and male taken off a waxbill at Onderstepoort. We have since taken it in the same locality off *Quelea sanguinirostris lathami* (pink-billed quelea).

2. **Machaerilaemus urocolius** Bedford (Fig. 13).

Machaerilaemus urocolius Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust.*, XVI, p. 157 (1930).

Described from specimens taken off *Urocolius indicus transvaalensis* (red-faced coly) at Ntambanana, Zululand, and at Onderstepoort. Specimens have also been taken off *U. indicus lacteifrons* (Damara red-faced coly), Khan River, South-West Africa (coll. R. D. Bradfield).

Genus Neumannia Uchida.

Neumannia Uchida, *Journ. Coll. Agric. Tokyo*, IX, p. 2 (1926).

Genotype: *Neumannia okadai* Uchida.

1. **Neumannia numidae** (Giebel).

Menopon numidae Giebel, *Ins. Epiz.*, p. 292 (1874).

M. (Menacanthus) numidae (Gie.) Neu., *Arch. Parasit.* XV, iii, p. 357, f. 3 (1912).

Tergites each with two rows of setae. Sternites without brushes of setae.

Recorded by Bedford (1919) taken off domestic fowls at Onderstepoort, and from *Numidia coronata*, Elandsfontein, Pretoria District, Transvaal. The skin of the latter is in the Transvaal Museum and proves to be *Numida papillosa transvaalensis*.

2. **Neumannia pallidula** (Neumann).

Menopon (Menacanthus) pallidulum Neu. *Arch. Parasit.*, XV, p. 361, f. 7-9 (1912).

Tergites each with one row of setae.

Described from specimens taken off domestic fowl. It will probably be found on fowls in South Africa.

Genus Eomenacanthus Uchida.

Eomenacanthus Uchida, *Journ. Coll. Agric. Tokyo*, IX, p. 30 (1926).

Genotype: *Menopon biscriatum* Piaget = *M. stramineum* Nitzsch.

1. **Eomenacanthus stramineus** (Nitzsch).

Pedieulus meleagridis Panzer, *Faun. Ins. Germ.*, p. 51, f. 20 (1793), *nec Linné* 1758.

Menopon stramineum Nitzsch, in Giebel, *Ins. Epiz.*, p. 291 (1874).

Menopon biseriatum Piaget, *Pédieulines*, p. 469, Pl. 37, f. 2 (1880).

M. (Menacanthus) biseriatum (P.) Neu., *Arch. Parasit.*, XV, p. 358, f. 4 (1912).

Sternites IV and V with brushes of setae.

A common parasite on domestic fowls and turkeys in South Africa.

Genus Menacanthus Neumann.

Menacanthus Neumann, *Arch. de Parasit.*, XV, iii, p. 353 (1912).

Several species found on birds belonging to various orders are at present included in this genus.

Genotype: *Menacanthus robustus* (Kellogg).

1. **Menacanthus corvus** Bedford.

Menacanthus corvus Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVI, p. 155, f. 1-3 (1930).

Described from specimens taken off *Corvus albus Müll.* (pied crow), Aliwal North, C.P., and from *Heterocorax capensis* Lcht. (black crow) at Onderstepoort.

2. **Menacanthus crateropus** Bedford.

Menacanthus crateropus Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, p. 719, Pl. 4, f. 1 (1920).

Described from specimens taken off pied babbler, *Turdoides bicolor (= Crateropus bicolor)* and Jardine's babbler, *Turdoides jardinei (= Crateropus jardinei)* in the Rustenburg District, Transvaal.

3. **Menacanthus curuccae** (Schrank).

Pediculus curuccae Schrank, *Beyträge*, p. 113 (1776).

Menopon sinuatum Burmeister, *Hand.*, ii, p. 440 (1838).

Menopon minutum Nitzsch, in Giebel, *Ins. Epiz.*, p. 286, Pl. 15, f. 2 (1874).

Described from specimens taken off *Sylvia curruca* (common white throat), a migrant to South Africa.

4. **Menacanthus fulvofasciatus** (Piaget).

Menopon fulvofasciatum Piaget, *Pédiculines*, p. 417, Pl. 33, f. 3 (1880).

Recorded by Neumann (1912) taken off *Neophron percnopterus* (Egyptian vulture). It was described from specimens taken off *Buteo vulgaris.*

5. **Menacanthus giganteus** (Denny).

Menopon giganteum Denny, *Anoplur. Brit.*, p. 225, Pl. 21, f. 2 (1842).

Menopon latum Piaget, *Pédiculines*, p. 457, Pl. 37, f. 1 (1880).

Recorded by Bedford (1919) taken off a domestic pigeon at Onderstepoort, and from Cape turtle dove, *Afropelia capicola (= Turtur capicola)* at Blokspruit, Pretoria District, Transvaal.

6. **Menacanthus spiniferus** (Piaget).

Menopon spiniferum Piaget, *Pédiculines*, Suppl., p. 99, Pl. 10, f. 9 (1885).

Menopon (M.) spiniferum (Pia.) Neumann, *Archiv. de Parasit.*, XV, p. 363, f. 11 (1911).

Recorded by Bedford (1919) as *M. spinosus* (Piaget) taken off *Lamprocolius phoenictopterus bispecularis* (northern Cape glossy starling) at Jericho, Transvaal, and one ♀ from Layard's bulbul, *Loidorusa layardi (= Pycnonotus barbatus layardi)* at Pietermaritzburg, Natal. Specimens have also been taken off *Melaenornis ater* (black flycatcher) at Ntambanana, Zululand (coll. G.A.H.B.); Norwich canary and *Acridotheres tristis* (Indian minor) at Pietermaritzburg (coll. L. Hill).

Genus Hirundoecus Ewing.

Hirundoecus Ewing, *Proc. U.S. Nat. Mus.*, LXXVII, Art. 20, p. 12 (1930).

This genus contains two species found on Hirundinidae

Genotype: *Hirundoecus americanus* Ewing.

1. **Hirundoecus malleus** (Nitzsch).

Eureum malleus Nitzsch, in Burmeister, *Handbuch*, II, p. 441 (1838).

Eureum malleus (N.) Piaget, *Pédiculines*, Suppl., p. 139, Pl. 15, f. 3 (1885).

Described from specimens taken off *Hirundo rustica* (European swallow).

Genus Eureum Nitzsch.

Eureum Nitzsch, *Germar's Magazin*, III, p. 301 (1818).

Eurem (Nitzsch) Ewing, *Proc. U.S. Nat. Mus.*, LXXVII, Art. 20, p. 10 (1930).

This genus includes a single species.

Genotype: *Eureum cimicoides* Nitzsch.

1. **Eureum cimicoides** Nitzsch.

Eureum cimicoides Nitzsch, in Burmeister, *Handb.*, II, p. 441 (1838).

Eureum cimicoides (N.) Denny, *Anoplur. Brit.*, p. 237, Pl. 22, f. 4 (1842).

Eureum cimicoides (N.) Piaget, *Pédiculines*, Suppl., p. 137, Pl. 15, f. 2 (1885).

Eureum cimicoides (N.) Ewing, *Proc. U.S. Nat. Mus.*, LXXVII, Art. 20, p. 10, f. 5 (1930).

Described from specimens taken off European swift, *Micropus apus (= Cypselus apus)*, a migrant to South Africa.

Genus Dennyus Neumann.

Nitzschia Denny, *Anoplur. Brit.*, p. 230 (1842), *nec* Baer, 1827.

Dennyus Neumann, *Bull. Soc. Zool. France*, XX, p. 59 (1906).

Dennyus Ferris, *Canad. Ent.*, p. 309 (Sept. 1916).

Takamatsuia Uchida, *Journ. Coll. Agric. Tokyo*, IX, p. 32 (1926).

Dennyus Ewing, *Proc. U.S. Nat. Mus.*, LXXVII, Art. 20, p. 2 (1930).

This genus includes thirteen species found on swifts.

Genotype: *Nirmus truncatus* von Olfers.

1. **Dennyus minor** (Kellogg and Paine).

Nitzschia minor Kell. and Paine, *Rec. Ind. Mus.*, X, p. 242, Pl. 15, f. 10 (1914).

This species is very closely allied to *D. truncatus* and may prove to be a synonym of that species. It was described from immature specimens taken off an Indian swift, *Colletoptera affinis (=Cypselus affinis)* in India. I have taken both adults and immature specimens off the same host in Pretoria.

2. **Dennyus truncatus** (von Olfers).

Nirmus truncatus von Olfers, *De Vegatatires*, etc., p. 91 (1816).

Nitzschia burmeisteri Denny, *Anoplur. Brit.*, p. 230, Pl. 22, f. 5 (1842).

Nitzschia pulicaris Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XVIII, p. 304 (1861).

Nitzschia tibialis Piaget, *Pédiculines*, p. 576, Pl. 48, f. 5 (1880).

Described fom specimens taken off European swift, *Micropus apus (= Cypselus apus)*, a migrant to South Africa.

Genus Myrsidea Waterston.

Myrsidea Waterston, *Ent. Month. Mag.*, LI, p. 12 (1915).

Myrsidea Ferris, *Canad. Ent.*, p. 307, f. 10b, 14, Sept., 1916.

The majority of the species included in this genus were formerly placed in the genus *Menopon*. They occur for the most part upon *Passeriformes*, particularly the *Corvidae*, but also occur upon certain families of *Coraciiformes*.

Genotype: *Myrsidea victrix* Waterston.

1. **Myrsidea cucullaris** (Nitzsch).

Menopon cucullare Nitzsch, in Burmeister, *Handb.*, II, p. 439 (1838).

Menopon flavescens Piaget, *Pédiculines*, p. 439, Pl. 35, f. 9 (1880).

Described from specimens taken off *Sternus vulgaris* (starling) in Europe.

2. **Myrsidea nigra** (Kellogg and Paine).

Menopon nigrum Kellogg and Paine, *Bull. Ent. Res.*, II, p. 151, Pl. 5, f. 4 (1911).

Described from specimens taken off *Corvultur albicollis* (white-necked raven) in Southern Nigeria.

3. **Myrsidea obovata** (Piaget).

Menopon obovatum Piaget *Pédiculines*, p. 429, Pl. 34, f. 1 (1880).

Described from specimens taken off pied crow, *Corvus albus (= C. scapulatus)* in the Leyden Museum.

4. **Myrsidea ovata** (Piaget).

Menopon ovatum Piaget, *Pédiculines*, p. 430, Pl. 34, f. 6 (1880).

Described from specimens taken off pied crow, *Corvus albus (=C. scapulatus).*

5. **Myrsidea rustica** (Nitzsch).

Menopon rusticum Nitzsch, in Giebel, *Ins. Epiz.*, p. 288 (1874).

Described from specimens taken off *Hirundo rustica* (European swallow). Waterston (1914) has recorded it from the same host in South Africa, and Bedford (1919) from house martin, *Chelidonaria urbica (= Delichon urbica)* at Blokspruit, Pretoria District, Transvaal.

6. **Myrsidea sjoestedti** (Kellogg).

Colpocephalum sjoestedti Kellogg, *Schwed. Exp. Kilimanjaro*, p. 50, Pl. 7, f. 7 (1910).

Described from specimens taken off pied crow, *Corvus albus (= C. scapulatus)* and *Corvultur albicollis* (white-necked raven), in East Africa.

Genus Neomenopon Bedford.

Neomenopon Bedford, *Parasit.*, XII, ii, p. 170 (1920).

This genus contains a single species.

1. **Neomenopon pteroclurus** Bedford.

Neomenopon pteroclurus Bedford, *Parasit.*, XII, ii, p. 170, Pl. 13, f. 1, 2 (1920).

Described from females taken off Namaqua sand-grouse, *Pterocles namaquus (= Pteroclurus namaqua)* in the Rustenburg District, Transvaal.

Genus Trinoton Nitzsch.

Trinoton Nitzsch, *Germar's Magazin*, III, p. 300 (1818).

Trinotum Burmeister, *Handb. der Ent.*, ii, p. 440 (1838).

Trinoton Piaget, *Les Pédiculines*, p. 587 (1880).

This genus contains ten species found on ducks, geese and swans.

Genotype: *Pediculus anserinus* Fabr.

1. **Trinoton aculeatum** Piaget.

Trinoton aculeatum Piaget, *Les Pédiculines*, Suppl., p. 136, Pl. 15, f. 1 (1885).

This species was described from specimens taken off *Dendrocygna viduata* in the Leyden Museum. Bedford (1919) has recorded it taken off the following hosts in the Rustenburg

District, Transvaal: *Dendrocygna viduata* (white-faced duck), *Sarkidiornis melanotus africanus* (knob-billed duck), *Casarca cana* (South African shelduck), and *Thalassornis leuconotus* (white-backed duck).

2. **Trinoton anserinum** (Fabricius).

Pediculus anserinus Fabricius, *Syst. Nat.*, p. 345 (1805).

Trinotum conspurcatum Nitzsch, in Burn., *Handb.*, II, p. 440 (1838).

Trinoton conspurcatum (Nitz.) Piaget, *Pédiculines*, p. 588, Pl. 44, f. 2 (1880).

Trinoton continuum Piaget, *ibid.*, p. 591 (1880).

Trinoton anserinum (Fabr.) Ferris, *Parasit.*, XX, p. 226, f. 9 a-e (1928).

Recorded by Bedford (1919, 1929) taken off *Plectropterus gambensis* (spurwing goose) in the Rustenburg District, Transvaal; also off the same host on the Kunene River, S.W.A., and from *Alopochen aegyptiacus* (Egyptian goose) at Tamanzu, S.W.A. It has also been recorded from swans, the domestic goose and other geese in Europe, and from geese in America.

3. **Trinoton femoratum** Piaget.

Trinoton femoratum Piaget, *Pédiculines*, p. 593, Pl. 49, f. 4 (1880).

Recorded by Bedford (1920) taken off greater flamingo, *Phoenicopterus major (= P. roseus)* at Durban. It was described from specimens taken off *Phoenicopterus major (= P. antiquorum)* in the Zoological Gardens at Rotterdam.

4. **Trinoton querquedulae** (Linné).

Pediculus querquedulae Linné, *Syst. Nat.*, p. 612 (1758).

Trinotum luridum Nitzsch, in Burm., *Handb.*, II, p. 441 (1838).

Trinotum lituratum Nitzsch, in Burm., *Handb.*, II, p. 441, (1838).

Trinoton luridum (Nitzsch) Piaget, *Les Pédicul.*, p. 591, Pl. 44, f. 3 (1880).

Trinoton lituratum (Nitzsch) Piaget, *ibid*, p. 597, Pl. 49, f. 7 (1880).

Recorded by Bedford (1919) taken off the following species of ducks in the Rustenburg District, Transvaal: *Sarkidiornis melanotus africanus* (Knob-billed duck); *Casarca cana* (South African shelduck); red-billed teal, *Paecilonitta erythrorhyncha (= Anas erythrorhyncha)* and *Nyroca capensis* (South African pochard). I have also taken it off *Notanetta capensis* (Cape wigeon) at Onderstepoort on the 1st July, 1930. This species has also been recorded from various ducks both in Europe and America. All the figures of *T. lituratum* I have seen are immature specimens of this species.

Genus CHAPINIA Ewing.

Chapinia Ewing, *Journ. Wash. Acad. Sci.*, XVII, iv, p. 88 (1927).
Bucerophagus Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 509 (1929).

This genus comprises three species found on hornbills.

Genotype: *Chapinia robusta* Ewing.

1. **Chapinia africana** (Bedford).

Bucerophagus africanus Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 509, f. 11, 11a, 12 (1929).

Described from specimens taken off *Bucorvus schlegeli* (South African ground-hornbill) in the Zoological Gardens, Pretoria; at Mafa, South-West Africa, and in the gardens at Groot Schuur, Capetown. The bird in the Zoological Gardens at Pretoria came from Rhodesia.

Genus EUCOLPOCEPHALUM Bedford.

Eucolpocephalum Bedford, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVI, p. 161 (1930).

This genus contains a single species.

1. **Eucolpocephalum robustum** Bedford.

E. robustum Bedford, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVI, p. 161, f. 6 (1930).

Described from females and males taken off *Platalea alba* (African spoonbill) at Capetown.

Genus HELEONOMUS Ferris.

Heleonomus Ferris, *Canadian Entomologist*, p. 305 (Sept., 1916).

This genus contains six species found on Gruidae.

Genotype: *Colpocephalum truncatum* Piaget.

1. **Heleonomus confusus** Ferris.

Colpocephalum miandrium Kellogg, *Schwed. Exp. Kilimanjaro*, p. 53, Pl. 7, f. 10 (1910), ♀ only.

Heleonomus confusus Ferris, *Canad. Ent.*, p. 307 (Sept., 1916).

Described from specimens taken off *Balearica regulorum gibbericeps* in East Africa. There are specimens in the South African Museum, Capetown, taken off *B. regulorum* (crowned crane).

2. **Heleonomus harrisoni** (Bedford).

Colpocephalum harrisoni Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, p. 720, Pl. 2, f. 7 (1919).

Described from two females reported to have been taken off a bustard in Angola, but probably taken from a crane.

3. **Heleonomus miandrius** (Kellogg).

Colpocephalum miandrius Kellogg, *Schwed. Exp. Kilimanjaro*, p. 53 (1910), ♂ only.

Heleonomus miandrius (Kell.) Ferris, *Canad. Ent.*, f. 12, 13E (1908).

Recorded by Bedford (1929) taken off *Balearica regulorum* crowned crane) on the Kunene River, South-West Africa. It was described from specimens taken off *B. regulorum gibbericeps* in East Africa.

Genus *Actornithophilus* Ferris.

Actornithophilus Ferris, *Canadian Entomologist*, p. 303 (Sept., 1916).

This genus includes a number of species found on Charadriiformes.

Genotype: Colpocephalum uniseriatum Piaget.

1. **Actornithophilus affine** (Nitzsch).

Colpocephalum affine Nitzsch, in Giebel, *Ins. Epiz.*, p. 276 (1874).

Recorded by Piaget (p. 561, 1880) taken off green sandpiper, *Tringa erythropus (= Totanus ochropus).* The type host is *Totanus maculatus.*

2. **Actornithophilus bicolor** (Piaget).

Colpocephalum bicolor Piaget, *Pédiculines*, p. 561, Pl. 47, f. 1 (1880).

Described from specimens taken off turnstone, *Arenaria interpres (= Strepsilas interpres),* a migrant to South Africa.

3. **Actornithophilus brachycephalus** (Giebel).

Colpocephalum brachycephalum Giebel, *Ins. Epiz.*, p. 278 (1874).

Described from specimens taken off large white-necked skua *Coprotheres pomarina (= Lestris pomarina).*

4. **Actornithophilus crassipes** (Piaget).

Colpocephalum crassipes Piaget, *Pédiculines*, p. 566, Pl. 46, f. 6 (1880).

Described from specimens taken off swift tern, *Thalasseus bergii (= Sterna bergii)* in the Leyden Museum.

5. **Actornithophilus epiphanes** (Kellogg and Chapman).

Colpocephalum epiphanes Kell. & Chap., *Journ. N.Y. Ent. Soc.*, X, p. 161, Pl. 14, f. 2 (1902).

Described from specimens taken off *Anous stolidus* (noddy).

6. **Actornithophilus latifasciatus** (Piaget).

Colpocephalum latifasciatum Piaget, *Pédiculines, Suppl.*, p. 130, Pl. 14, f. 2 (1885).

Described from specimens taken off *Rhynchops flavirostris* (African skimmer).

7. **Actornithophilus patellatus** (Piaget).

Colpocephalum patellatum Piaget, *Tijd. v. Ent.*, XXXIII, p. 254, Pl. 10, f. 8 (1888).

Described from specimens taken off *Numenius arquatus* (curlew), a migrant to South Africa.

8. **Actornithophilus piceus** (Denny).

Colpocephalum piceum Denny, *Anoplur. Brit.*, p. 212, Pl. 18, f. 4 (1842).

C. maurum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 395 (1866).

C. maurum (N.) Piaget, *Pédiculines*, p. 564, Pl. 47, f. 4 (1880).

Described from specimens taken off sandwich tern, *Thalasseus sandvicensis* (= *Sterna cantiaca*). It has also been recorded from swift tern, *Thalasseus bergii* (= *Sterna bergii*) and other species of terns.

9. **Actornithophilus pustulosus** (Piaget).

Colpocephalum pustulosum Piaget, *Pédiculines*, p. 559, Pl. 46, f. 8 (1880).

Described from specimens taken off the ruff and reeve, *Philomachus pugnax* (= *Machetes pugnax*). We have taken specimens off the same host at Onderstepoort.

10. **Actornithophilus spinulosus** (Piaget).

Colpocephalum spinulosum Piaget, *Pédiculines*, p. 563, Pl. 47, f. 3 (1880).

Described from specimens taken off black-tailed godwit, *Limosa limosa* (= *L. melanura*).

11. **Actornithophilus trilobatus** (Giebel).

Colpocephalum trilobatum Giebel, *Ins. Epiz.*, p. 275 (1874).

Described from specimens taken off little stint, *Pisobia minuta* (= *Tringa minuta*).

12. **Actornithophilus umbrinus** (Nitzsch).

Colpocephalum umbrinum Nitzsch, in Burmeister, *Handbuch*, II, p. 438 (1838).

C. cornutum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 395 (1866).

C. cornutum (N.) Giebel, *Ins. Epiz.*, p. 274 (1874).

Described from specimens taken off curlew sandpiper, *Erolia testacea* (= *Tringa subarquata*). *C. cornutum* was described from specimens taken off the ruff and reeve, *Philomachus pugnax* (= *Machetes pugnax*). Both hosts are migrants to South Africa.

13. **Actornithophilus umbrosus** (Harrison).

Colpocephalum umbrinum Piaget, *Pédiculines*, p. 556, Pl. 46, f. 6 (1880), *nec* Nitzsch, 1838.

C. umbrosum Harrison, *Parasit.*, IX, i, p. 56 (1916).

Described from specimens taken off curlew sandpiper, *Erolia testacea* (= *Tringa subarquata*). Waterston (1914) has recorded it taken off the same host in South Africa.

14. **Actornithophilus uniseriatus** (Piaget).

Colpocephalum uniseriatum Piaget, *Pédiculines*, p. 562, Pl. 47, f. 2 (1880).

Described from specimens taken off *Recurrirostra avosetta* (avocet), a migrant to South Africa.

Genus Tetrophthalmus Grosse.

Piagetia Picaglia, *Attid. Soc. Nat. Modena, Rend. d. Adunanze*, II, p. 104 (1884), *nec* Ritsema, 1874.

Tetrophthalmus Grosse, *Zeit. f. wiss. Zool.*, XLII, p. 534 (1885).

Piagetiella Neumann, *Bull. Soc. Zool. France*, XX, p. 59 (1906).

This genus comprises ten species found on Pelecanidae

Genotype: *Tetrophthalmus chilensis* Grosse.

1. **Tetrophthalmus africanus** Bedford.

T. africanus Bedford, *Parasit.*, XXIII, ii, pp. 236-242, f. 1C-6C (1931).

Described from specimens found on *Neopelecanus rufescens* (pink-backed pelican), in the Zoological Gardens, Pretoria.

2. **Tetrophthalmus subtitan** Bedford.

T. subtitan Bedford, *Parasit.*, XXIII, ii, pp. 236-242, f. 1B-6B (1931).

Described from a female and male taken off *Metapelecanus roseus* (eastern white pelican) at the junction of the Olifant and Limpopo Rivers, Mozambique.

3. **Tetrophthalmus titan** (Piaget).

Menopon titan Piaget, *Pédiculines*, p. 503, Pl. 40, f. 7 (1880).

T. titan (Piaget) Bedford, *Parasit.*, XXIII, ii, pp. 236-242, f. 1A-6A (1931).

Described from specimens taken off *Pelecanus onocrotalus* (European pelican), a rare visitor to South Africa.

Genus Psittacomenopon Bedford.

Psittacomenopon Bedford, *Rep. Dir. Vet. Serv. & Anim. Indust., Un. S. Afr.*, XVI, p. 154 (1930).

The species included in this genus are all parasitic on Psittacidae (parrots).

Genotype: *Menopon poicephalum* Bedford.

1. **Psittacomenopon poicephalum** (Bedford).

Menopon impar. var. poicephalus Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 718 (1920).

Described from a female and male taken off *Poicephalus meyeri damarensis* (Meyer's parrot), Rooikuil, Transvaal. Bedford (1930) also recorded specimens from *Poicephalus robustus* (Cape parrot), Haenertsburg, Transvaal.

Genus CUCULIPHILUS Uchida.

Cuculiphilus Uchida, *Journ. Coll. Agric. Tokyo*, IX, p. 47 (1926).

The species included in this genus are parasitic on Cuculidae (cuckoos).

Genotype: *Pediculus fasciatus* Scopoli.

1. **Cuculiphilus fasciatus** (Scopoli).

Pediculus fasciatus Scopoli, *Ent. Carn.*, p. 383 (1763).

Pediculus cuculi Fabricius, *Syst. Ent.*, p. 807 (1775).

Menopon phanerostigma Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 391, (1866).

Menopon phanerostigma (N.) Giebel, *Ins. Epiz.*, p. 290, Pl. 14, f. 8 (1874).

Described from specimens taken off *Cuculus canorus* (European cuckoo), a migrant to South Africa. Specimens have also been collected by L. Hill off the following hosts at Pietermaritzburg, Natal: *Oxylophus cafer* (striped-breasted cuckoo), *Notococcyx solitarius* (red-chested cuckoo) and *Lampromorpha cuprea* (bronze cuckoo).

Genus KURODAIA Uchida.

Kurodaia Uchida, *Journ. Coll. Agric. Tokyo*, IX, p. 50 (1926).

Genotype: *Colpocephalum haliaeeti* Denny.

1. **Kurodaia haliaeeti** (Denny).

Colpocephalum haliaeeti Denny, *Anoplur. Brit.*, p. 216, Pl. 19, f. 1 (1842).

Described from specimens taken off *Pandion haliaetus* (osprey).

Genus COLPOCEPHALUM Nitzsch.

Colpocephalum Nitzsch, *Germar's Magazin*, III, p. 298 (1818).

Ferrisia Uchida, *Journ. Coll. Agric. Tokyo*, IX, p. 43 (1926).

This genus, which will eventually be split up, contains over a hundred species found on various birds.

Genotype: *Colpocephalum zebra* Nitzsch.

1. **Colpocephalum abruptofasciatum** Mjöberg.

C. abruptofasciatum Mjöberg, *Arkiv. f. Zool.*, VI, p. 36, f. 23 (1910).

Described from specimens taken off *Milvus aegyptius* (yellow-billed kite) at Cairo. It has also been taken off the same host in Zululand.

2. **Colpocephalum angulaticeps** Piaget.

C. angulaticeps Piaget, *Pédiculines*, p. 569, Pl. 47, f. 8 (1880).

Described from specimens taken off *Fregata minor* (frigate bird).

3. **Colpocephalum bicinctum** Nitzsch.

C. bicinctum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XVII, p. 524 (1861).

C. bicinctum (N.) Giebel, *Ins. Epiz.*, p. 263 (1874).

Described from specimens taken off *Circus aeruginosus* (European marsh harrier).

4. **Colpocephalum caudatum** Giebel.

C. caudatum Giebel, *Ins. Epiz.*, p. 261 (1874).

C. caudatum (Gie.) Piaget, *Pédiculines*, p. 518, Pl. 43, f. 3 (1880).

Recorded by Bedford (1920) taken off Cape vulture, *Gyps coprotheres (= G. kolbei)* in the Pretoria District, Transvaal, and from *Pseudogyps africanus* (southern white-backed vulture) in the Rustenburg District, Transvaal. The type host is *Vultur indicus.*

5. **Colpocephalum cucullare** Giebel.

C. cucullare Giebel, *Ins. Epiz.*, p. 264 (1874).

C. caudatum var. major Piaget, *Pédiculines*, p. 519 (1880).

Recorded by Waterston (1914) taken off the type host, the secretary bird, *Sagittarius serpentarius (= Gypogeranus serpentarius) in South Africa.* In the Onderstepoort collection there are specimens taken off the same host in the Rustenburg District, Transvaal.

6. **Colpocephalum decimfasciatum** Boisduval and Lacordavie.

C. decimfasciatum Bois. and Lac., *Faun. Ent. Env. Paris*, p. 123 (1835).

C. impostunum Nitzsch, in Denny, *Anoplur. Brit.*, p. 214, Pl. 18, f. 1 (1842).

C. impostunum (Nitz.) Piaget, *Pédiculines*, p. 548, Pl. 45, f. 8 (1880).

Described from specimens taken off *Ardea cinerea* (common grey heron). Specimens have been taken off *Ardea melanocephala* (black-headed heron) in the Zoological Gardens, Durban. Piaget (p. 549, 1880), described a variety *major* (*nec* Piaget, p. 519, 1880) from little egret, *Egretta garzetta (= Ardea garzetta)* and European little bittern, *Ixobrychus minutus (= Ardea minuta).*

7. **Colpocephalum dissimile** Piaget.

C. dissimile Piaget, *Pédiculines*, p. 520, Pl. 43, f. 4 (1880).

Described from specimens taken off *Milrus aegyptius* (yellow-billed kite) in the Leyden Museum.

8. **Colpocephalum ephippiorhynchi** Mjöberg.

C. ephippiorhynchi Mjöberg, *Arkiv. f. Zool.*, VI, p. 43, Pl. 3, f. 9 (1910).

Described from specimens taken off *Ephippiorhynchus senegalensis* (saddle-bill stork) at Khartoum, Sudan.

9. **Colpocephalum eucarenum** Nitzsch.

C. eucarenum Nitzsch, in Burmeister, *Handbuch*, II, p. 439 (1838).

C. eucarenum (N.) Giebel, *Ins. Epiz.*, p. 276, Pl. 16, f. 1 (1874).

Described from specimens taken off *Pelecanus onocratalus* (European pelican). This bird has recently been found on the coast of Zululand.

10. **Colpocephalum ferrisi** Bedford.

C. ferrisi Bedford, *Rep. Dir. Vet. Serv. and Anim. Indust., Un. S. Afr.*, XVI, p. 159, f. 5a-d (1930).

Described from males taken off *Melanopelargus niger* (black stork), Nomgas, South-West Africa.

11. **Colpocephalum flavescens** Nitzsch.

C. flavescens Nitzsch, in Lyonet, *Mém. Mus*,. XVIII, p. 262, Pl. 12, f. 1 (1829).

C. flavescens Piaget, *Pédiculines*, p. 515, Pl. 42, f. 10 (1880).

This species has been recorded from various Falconiformes. Piaget (1880) recorded it from *Gyps rüppelli* (Rüppel's vulture), *Pernis apivorus* (honey buzzard) and peregrine falcon, *Rhynchodon peregrinus (= Falco peregrinus)*. He (p. 119, 1885) also described a variety found on *Pandion haliaetus* (osprey).

12. **Colpocephalum furcatum** Rudow.

C. furcatum Rudow, *Zeit. f. ges. Nat.*, XXVII, p. 472 (1866).

Described from specimens taken off soft-plumaged petrel, *Pterodroma mollis (= Procellaria mollis)*.

13. **Colpocephalum heterosoma** Piaget.

C. heterosoma Piaget, *Pédiculines*, p. 572, Pl. 48, f. 3, 4 (1880).

Described from specimens taken off greater flamingo, *Phoenicopterus major (= P. antiquorum)*.

14. **Colpocephalum longissimum** Rudow.

C. longissimum Rudow, *Zeit. f. ges. Nat.*, XXXIV, p. 398 (1869).

C. longissimum (Rud.) Giebel, *Ins. Epiz.*, p. 273 (1874).

Described from specimens taken off *Leptoptilus crumeniferus* (marabou stork).

15. **Colpocephalum nyctarde** Denny.

C. nyctarde Denny, *Anoplur. Brit.*, p. 215, Pl. 20, f. 9 (1842).

Described from specimens taken off night heron, *Nycticorax nycticorax (= Ardea nycticorax).*

16. **Colpocephalum occipitale** Nitzsch.

C. occipitale Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 394 (1866).

C. occipitale (N.) Piaget, *Pédiculines*, p. 547, Pl. 45, f. 7 (1880).

Described by Piaget from specimens taken off *Anastomus lamelligerus* (openbill stork). Giebel described it from specimens taken off *Anastomus coromandelicus.*

17. **Colpocephalum ocellatum** Rudow.

C. ocellatum Rudow, *Zeit. f. ges. Nat.*, XXXIV, p. 392 (1869).

C. ocellatum (Rud.) Giebel, *Ins. Epiz.*, p. 275 (1874).

Described from specimens taken off whimbrel, *Phaeopus phaeopus (= Numenius phaeopus).* It is most probably a species of *Actornithophilus.*

18. **Colpocephalum oreas** Kellogg.

C. oreas Kellogg, *Schwed. Exp. Kilimanjaro*, p. 51, Pl. 7, f. 8 (1910).

Described from specimens taken off *Ephippiorhynchus senegalensis* (saddlebill stork) and African great white heron, *Casmerodius albus melanorhynchus (= Herodias alba)* in East Africa. Their presence on the one bird was due to straggling, but on which bird is not certain. Both birds occur in South Africa.

19. **Colpocephalum pediculoides** Mjöberg.

C. pediculoides Mjöberg, *Arkiv. f. Zool.*, VI, p. 44, Pl. 2, f. 6 (1910).

Described from two specimens taken off a turnstone, *Arenaria interpres (= Strepsilas interpres)*, a migrant to South Africa, and one specimen from *Falco tinnunculi.*

20. **Colpocephalum pingue** Kellogg.

C. pingue Kellogg, *New Mallophaga*, I, p. 144, Pl. 12, f. 5 (1896).

Recorded by Waterston (1914) taken off *Diomedea exulans* (wandering albatross) in the Cape Province. It was described from specimens taken off *Diomedea albatrus* and *D. nigripes.*

21. **Colpocephalum pygidiale** Mjöberg.

C. pygidiale Mjöberg, *Arkiv. f. Zool.*, VI, p. 46, Pl. 3, f. 8 (1910).

Recorded by Bedford (1919) taken off the type host, the sacred ibis, *Threskiornis aethiopica (= Ibis religiosa)* in the Rustenburg District, Transvaal. I have also taken specimens off the same host in northern Zululand.

22. **Colpocephalum quadripustulatum** Nitzsch.

C. quadripustulatum Nitzsch, in Burmeister, *Handbuch*, II, p. 438 (1838).

C. quadripustulatum (N.) Piaget, *Pédiculines*, p. 546, Pl. 45, f. 6 (1880).

Specimens have been taken off the type host, *Ciconia ciconia* (white stork) at Pietermaritzburg, Natal (coll. L. Hill). Piaget (1880) described specimens from *Ciconia ciconia (= C. alba)* and black stork, *Melanopelargus niger (= C. nigra)*, the latter also occurring in South Africa.

23. **Colpocephalum semicinctum** Rudow.

C. semicinctum Rudow, *Zeit. f. ges. Nat.*, XXVII. p. 475 (1866).

C. semicinctum (Rud.) Piaget, *Pédiculines*, p. 528, Pl. 44, f. 1 (1880).

Recorded by Bedford (1920) taken off the type host, the pied crow, *Corvus albus (= C. scapulatus)* from Lamberts Bay, C.P., and at Beira, East Africa.

24. **Colpocephalum scopinum** Mjöberg.

C. scopinum Mjöberg, *Arkiv. f. Zool.*, VI, p. 47, f. 25, 26 (1910).

Recorded by Bedford (1919) taken off *Scopus umbretta bannermani* (hammerhead) at Pietermaritzburg, Natal. It was originally described from specimens taken off *Scopus umbretta* in Madagascar.

25. **Colpocephalum subflavescens** Piaget.

C. subflavescens Piaget, *Pédiculines*, p. 571, Pl. 48, f. 2 (1880).

Described from specimens taken off open-bill stork, *Ephippiorhynchus senegalensis (= Xenorhynchus senegalensis)*.

26. **Colpocephalum subpachygaster** Piaget.

C. subpachygaster Piaget, *Pédiculines*, p. 517, Pl. 34, f. 2 (1880).

Recorded by Waterston (1914) taken off *Bubo capensis* (Cape eagle owl) in South Africa. Bedford (1919) recorded it from the same host at Pietermaritzburg, Natal, and from the Cape barn owl, *Typo alba affinis (= Strix flammea maculata)*. It was described from specimens taken off several species of owls.

27. **Colpocephalum subpenicillatum** Piaget.

C. subpenicillatum Piaget, *Pédiculines, Suppl.*, p. 123, Pl. 13, f. 6 (1885).

Recorded by Kellogg and Ferris (1915) and Bedford (1919) taken off the type host, the hadadah ibis, *Hagedashia hagedash (= Ibis hagedasch)* at Mfongosi, Zululand.

28. **Colpocephalum tricinctum** Nitzsch.

C. tricinctum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XVII, p. 524 (1861).

C. tricinctum (N.) Giebel, *Ins. Epiz.*, p. 263 (1874).

Described from specimens taken off black kite, *Milvus migrans (= M. ater).*

29. **Colpocephalum trochioxum** Nitzsch.

C. trochioxum Nitzsch, in Burmeister, *Handbuch*, II, p. 438 (1838).

C. trochioxum (N.) Piaget, *Pédiculines*, p. 550, Pl. 45, f. 9 (1880).

Described by Burmeister (1838) from specimens taken off little bittern, *Botaurus stellaris (= Ardea stellaris).* Piaget (1880) described it from specimens taken off the same host in the Zoological Gardens at Rotterdam, and from purple heron, *Pyrrherodia purpurea (= Ardea purpurea)* in the Leyden Museum.

30. **Colpocephalum turbinatum** Denny.

C. turbinatum Denny, *Anoplur. Brit.*, p. 209, Pl. 21, f. 1 (1842).

C. longicaudatum Nitzsch, in Giebel, *Zeit. f. ges. Nat.*, XXVIII, p. 394 (1866).

C. longicaudatum (N.) Piaget, *Pédiculines*, p. 534, Pl. 44, f. 6 (1880).

Recorded by Bedford (1919) from specimens taken off a domestic pigeon at Pietermaritzburg, Natal.

31. **Colpocephalum veratrum** Kellogg.

C. veratrum Kellogg, *Schwed. Exp. Kilimanjaro*, p. 52, Pl. 7, f. 9 (1910).

Described from specimens taken off African great white heron, *Casmerodius albus melanorhynchus (= Herodias alba)* in East Africa.

32. **Colpocephalum vittatum** Rudow.

C. vittatum Rudow, *Zeit. f. ges. Nat.*, XXVII, p. 469 (1866).

Recorded by Bedford (1929) taken off the type host, *Ardeola ralloides* (squacca heron) on the Kunene River, South-West Africa.

33. **Colpocephalum zebra** Nitzsch (Fig. 14B).

C. zebra Nitzsch, in Burmeister, *Handbuch*, II, p. 438 (1838).

C. zebra (Nitzsch) Ferris, *Parasit*, XVI, i, p. 59, f. 2 A-G (1924).

Recorded by Waterston (1914) taken off the type host, the white stork, *Ciconia ciconia (= C. alba)* in South Africa.

34. **Colpocephalum zonatum** Rudow.

C. zonatum Rudow, *Zeit. f. ges. Nat.*, XXXIV, p. 391 (1869).

Described from specimens taken off *Ardeola ralloides* (squacca heron).

Subfamily BOOPINAE.

This family contains twelve species found on Australian Marsupialia. One species also occurs on the domestic dog.

Genus HETERODOXUS Le Souëf and Bullen.

Heterodoxus Le Souëf and Bullen, *Vict. Naturalist*, XVIII, p. 159 (1902).

This genus contains two species.

Genotype: *Heterodoxus macropus* Le Souëf & Bullen = *Menopon longitarsus* Piaget.

1. **Heterodoxus longitarsus** (Piaget).

Menopon longitarsus Piaget, *Pédiculines*, p. 504, Pl. 41, f. 7 (1880).

Heterodoxus macropus Le Souëf and Bullen, *Vict. Naturalist*, XVIII, p. 159, f. 11 (1902).

Menopon spiniger Enderlein, *Jenais. Denks.*, XIV, p. 80 (1909).

M. (Menacanthus) spinigerum "Enderl." Neu., *Arch. de Parasit.*, XV, p. 364, f. 12 (1912).

Heterodoxus armiferus Paine, *Ent. News.*, p. 362, f. A (1912).

Heterodoxus longitarsus (Pia.) Harr. and Johnst., *Parasit.*, VIII, p. 353, f. 10, 11 (1916).

This species is very common on dogs in South Africa. It has also been found on dogs in other parts of Africa, America, Malay Peninsula, Japan and Formosa, and on its true hosts, kangaroos and wallabies, in Australia.

Family GYROPIDAE Burmeister.

This family contains twenty-six species found principally on rodents in South America.

Key to the South African Subfamilies.

1. Maxillary palpi four-segmented; six pairs of abdominal spiracles present; tarsi with at least one claw ... *Gyropinae*

Maxillary palpi two-segmented; five pairs of abdominal spiracles present; tarsal claws wanting ... *Gliricolinae*.

Subfamily GYROPINAE Ewing.

Genus GYROPUS Nitzsch.

Gyropus Nitzsch, *Germar's Magazin*, III, p. 303 (1818).

Gyropus Ewing, *Proc. U.S. Nat. Mus.*, LXIII, Art. 20, p. 12 (1924).

This genus contains seven species.

Genotype: Gyropus ovalis Nitzsch.

1. **Cyropus ovalis** Nitzsch.

Gyropus ovalis Nitzsch, in Burmeister, *Handbuch*, II, p. 443 (1838).

Gyropus ovalis (N.) Piaget, *Pédiculines*, p. 609, Pl. 50, f. 5 (1880).

Gyropus ovalis (N.) Ewing, *Proc. U.S. Nat. Mus.*, LXIII, Art. 20, p. 13, f. 6 (1924).

A common parasite of the guinea-pig (*Cavia cobaya*).

Subfamily GLIRICOLINAE Ewing.

Genus GLIRICOLA Mjöberg.

Gliricola Mjöberg, *Arkiv. f. Zool.*, VI, p. 18 (1910).

Gliricola Ewing, *Proc. U.S. Nat. Mus.*, LXIII, Art. 20, p. 31 (1924).

This genus contains two species and a variety.

Genotype: Pediculus porcelli Linné.

1. **Gliricola porcelli** (Linnaeus).

Pediculus porcelli Linné, *Syst. Nat.*, p. 611 (1758).

Gyropus gracilis Nitzsch, in Burmeister, *Handbuch*, II, p. 443 (1838).

Gyropus gracilis (N.) Piaget, *Pédiculines*, p. 611, Pl. 50, f. 6 (1880).

Gliricola porcelli (L.) Ewing, *Proc. U.S. Nat. Mus.*, LXIII, Art. 20, p. 33, f. 15, 17; Pl. 1, f. 8 (1924).

A common parasite of the guinea-pig *(Cavia cobaya).*

Family LAEMOBOTHRIIDAE Mjöberg.

This family includes two genera.

Key to the Genera.

1. Clypeus emarginate in front and bearing several peg-like setae on or near its anterior margin. On water birds *Eulaemobothrion.*

   Clypeus not emarginate in front and without peg-like setae. On Falconiformes ... ... *Laemobothrion.*

Genus Laemobothrion Nitzsch.

Laemobothrion Nitzsch, *Germar's Magazin*, III, p. 301 (1818).

Laemobothrium Burmeister, *Handbuch der Ent.*, II, p. 441 (1838).

Genotype: *Laemobothrion giganteum* Nitzsch = *Pediculus tinnunculi Linné.*

1. **Laemobothrion percnopteri** (Gervais).

Laemobothrium percnopteri Gervais, *Aptères*, III, p. 321, Pl. 48, f. 6 (1847).

Laemobothrium gigas Nitzsch in Giebel, *Zeit. f. ges. Nat.*, XVII, p. 518 (1861).

Laemobothrium pallidum Giebel, *Ins. Epiz.*, p. 250 (1874).

Described from specimens taken off *Neophron percnopterus* (Egyptian vulture).

2. **Laemobothrion tinnunculi** (Linnaeus).

Pediculus tinnunculi Linné, *Syst. Nat.*, p. 612 (1758).

L. giganteum Nitzsch, in Burmeister, *Handbuch*, II, p. 441 (1838).

L. nigrolimbatum Giebel, *Ins. Epiz.*, p. 252 (1874).

L. laticolle Nitzsch in Denny, *Anoplur. Brit.*, p. 239, Pl. 23, f. 4 (1842).

For other synonyms see Harrison (1916). Waterston (1914) has recorded this species taken from *Falco subbuteo* (hobby) in South Africa, and Bedford (1929) a ♂ taken off *Cerchneis rupicola* (Cape Kestrel) at Haenertsburg, Transvaal. It has also been recorded from numerous Falconiformes, including *Circus aeruginosus* (European marsh harrier) and *Gyps rüppelli* (Rüppell's vulture). The type host is *Falso tinnunculus.*

3. **Laemobothrion titan** (Piaget).

Laemobothrium titan Piaget, *Pédiculines*, p. 578, Pl. 49, f. 1 (1880).

Laemobothrium gypsis Kellogg, *Ent. News*, XVII, p. 63, f. 1 (1906).

Laemobothrium africanum Kellogg, *Schwed. Zool. Exp. Kilimanjaro*, p. 47, Pl. 7, f. 6 (1910).

L. titan was described from a ♀ taken off black kite, *Milvus migrans (= M. aetolius)*, *L. gypsis* from specimens taken off Cape vulture, *Gyps coprotheres (= G. kolbei)* in the Transvaal and *L. africanum* from immature specimens taken off *Pseudogyps africanus* (white-backed vulture) in East Africa. Bedford (1929) recorded specimens taken off the following hosts in South Africa: *Gyps coprotheres* (Cape vulture), *Pseudogyps africanus fullebornci* (southern white-backed vulture), *Pterolestes rufofuscus* (jackal buzzard) and *Nisaetus spilogaster* (African hawk-eagle) in the Rustenburg District, Transvaal; *Milvus aegyptius parasitus* (Cape kite), Pietermaritzburg, Natal; *Pteroaetus verreauxi* (black eagle), Mtabamhlope, Natal; *Buteo vulpinus* (steppe buzzard), Kaoko Otavi, South-West Africa, and from

Pandion haliaetus (osprey). Specimens have also been taken off *Circaetus pectoralis* (black-chested harrier-eagle), Hamanskraal, Transvaal (coll. M. Carlisle), and *Terathopius ecaudatus* (bateleur eagle), Hempton, Transvaal.

Genus Eulaemobothrion Ewing.

Eulaemobothrion Ewing, A Manual of External Parasit., p. 189 (1929).

Genotype: *Laemobothrion nigrum* Burmeister.

This genus comprises about twelve species found on Rallidae, Plegadidae, etc.

1. **Eulaemobothrion kelloggi** (Bedford).

Laemobothrium setigerum var. africanum Kellogg & Ferris, *Ann. Durban Mus.*, I, p. 147, Pl. 15, f. 1 (1915), *nec* Kellogg, 1910.

Laemobothrium kelloggi Bedford, *Rep. Dir. Vet. Res. Un. S. Afri.*, V & VI, p. 723 (1919).

Described from specimens taken off hadadah ibis, *Hagedashia hagedash (= Theristicus hagedasch)* at Mfongosi, Zululand.

Family RICINIDAE Neumann.

Genus Ricinus Degeer.

Ricinus Degeer, *Mém. pour serr. à l'hist. des insectes*, VII, p. 69 (1778).

Physostomum Nitzsch, *Germar's Mag.*, III, p. 302 (1818).

This genus contains thirty-five species found on passerine birds.

Genotype: *Ricinus fringillae* Degeer (1778), *nec* Scopoli, 1772. = *Physostomum nitidissimum* Nitzsch.

1. **Ricinus dolichocephalus** (Scopoli).

Pediculus dolichocephalus Scopoli, *Ent. Carn.*, p. 382 (1763).

Pediculus orioli Fabricius, *Gen. Ins.*, p. 309 (1776).

Physostomum sulphureum Nitzsch, in Burmeister, *Handbuch*, II, p. 442 (1838).

Physostomum sulphureum (N.) Giebel, *Ins. Epiz.*, p. 256, Pl. 18, f. 4 (1874).

Specimens of this species taken off *Oriolus larvatus larvatus* (black-headed oriole) at Pietermaritzburg, Natal, have been forwarded by Mr. L. Hill for identification. It was described from specimens taken off European golden oriole, *Oriolus oriolus (= O. galbula)*, a migrant to South Africa.

2. **Ricinus longetarsatus** (Piaget).

Physostomum longetarsatum Piaget, *Tijd. v. Ent.*, XXXVIII, p. 101 (1895).

Described from specimens taken off *Lamprotornis sp.* in the Transvaal.

Suborder RHYNCOPHTHIRINA.

This suborder contains a single species.

Family HAEMATOMYZIDAE Enderlein.

Genus HAEMATOMYZUS Piaget.

Haematomyzus Piaget, *Tijd. v. Ent.*, XII, p. 254 (1869).

Idolocoris " Walker " Richter, *Hardwick's Science Gossip*, p. 131 (1871).

Phantasmocoris F. Buchanan White, *ibid.*, p. 234 (1871).

1. **Haematomyzus elephantis** Piaget.

Haematomyzus elephantis Piaget, *Tijd. v. Ent.*, XII. p. 254 (1869).

Haematomyzus proboscideus Piaget, *Pédiculines*, p. 658, Pl. 54, f. 2-2h (1880).

Haematomyzus elephantis var. sumatranus Fahrenholz, *Zool. Anzeig.* XXXV, p. 714 (1910).

Haematomyzus elephantis (Pia.) Ferris, *Parasit.*, XXIII, i, pp. 112-127, f. 1-5 and Pls. 4, 5 (1931).

The type specimens were taken off a young African elephant. Bequaert (Rep. Harv.-Afr. Exp. Liberia and Belg. Congo, p. 997, 1931) recorded it from the same host in the Belgian Congo. It has also been recorded from *Elephas indicus* and *E. sumatranus*. I have taken numerous specimens off a young Indian elephant at Pretoria North.

Suborder SIPHUNCULATA.

About 200 described species are included in this suborder. They are all parasitic on mammals, and are chiefly found on rodents, ungulates and primates.

Key to the Families.

1. Abdomen thickly beset with either stout spines or with spines and scales. Parasitic on marine carnivores ECHINOPHTHIRIIDAE.

   Abdomen either with spines or setae arranged in definite rows, or with chitinous points, giving the body a scaly appearance 2

2. Eyes absent; pleural plates sometimes vestigal or wanting. Not parasitic on primates HAEMATOPINIDAE, p. 399.

   Eyes or eye tubercles present; pleural plates usually well developed. Parasitic on primates 3

3. Abdomen with normal segmentation and without lateral tubercles ... ... PEDICULIDAE, p. 412.

   Abdomen with segments III to V fused; first three spiracles close together; lateral tubercles present PHTHIRIDAE, p. 414.

Family ECHINOPHTHIRIIDAE Enderlein.

Subfamily ANTARCTOPHTHIRIINAE Enderlein.

Genus Lepidophthirus Enderlein.

Lepidophthirus Enderlein, *Zool. Anz.*, XXVIII, pp. 43, 137 (1904).

This genus comprises a single species. The antennae are four-jointed; thorax and abdomen beset with delicate scales and numerous spines; forelegs much smaller than mid and hind legs.

1. **Lepidophthirus macrorhini** Enderlein.

L. macrorhini, Enderl., *Zool. Anz.*, XXVIII, pp. 46, f. 1-5 (1904).

Bedford (1929) recorded numerous specimens taken off *Macrorhinus leoninus* (giant seal) captured off the coast near Capetown. It was described from specimens taken off the same host on Kerguelen Island.

Family HAEMATOPINIDAE Enderlein.

Key to the South African Subfamilies and Genera.

1. Fore legs smaller than one or both of the other pairs 2
   Legs and claws subequal. Parasitic on ungulates. Subfamily HAEMATOPININAE ... ... *Haematopinus*, p. 411.

2. Fore legs smaller than mid and hind legs 3
   Fore and mid legs equal in size, and much smaller than hind legs ... ... Subfamily ENDERLEINELLINAE 6

3. Anterior tarsi with a short, claw-like process in addition to the claw ... ... Subfamily HYBOPHTHIRINAE 7
   Anterior tarsi without a claw-like process in addition to the the claw 4

4. Abdomen with distinct pleural plates on some of the segments ... ... Subfamily HOPLOPLEURINAE 8
   Pleural plates on abdomen either absent or very rudimentary 5

5. Abdomen with small chitinous points, giving it a scaly appearance, and with one pair of spiracles. Parasitic on elephant shrews. Subfamily NEOLINOGNATHINAE ... ... *Neolinognathus*, p. 407.
   Abdomen clothed with normal setae and with six pairs of spiracles. Parasitic on ungulates and Leporidae Subfamily LINOGNATHINAE 12

6. Second abdominal sternite without plates; five to seven pairs of pleural plates present. Parasitic on mole rats *Proenderleinellus*, p. 400.
   Second abdominal sternite with a pair of small sclerites, each with a backward-pointing chitinous process; three to five pairs of pleural plates present; parasitic on squirrels ..., ... *Enderleinellus*, p. 401.

7. Seven pairs of pleural plates present. Parasitic on Cape ant bear ... ... *Hybophthirus*, p. 401.
Six pairs of pleural plates present. Parasitic on cane rats and rock rats ... ... *Scipio*, p. 402.

8. Rostrum surrounded by denticles; tergites with a single transverse row of truncate setae. Parasitic on spring hares ... ... *Eulinognathus*, p. 402.
Rostrum not surrounded by denticles; median tergites of ♀ with two or three transverse rows of setae 9

9. Median abdominal tergites and sternites of ♀ with two transverse rows of setae 10
Median abdominal tergites and sternites of ♀ usually with three transverse rows of setae, rarely three rows only on the third tergite and sternite 11

10. Pleural plates of second abdominal segment not divided. Parasitic on squirrels ... ... *Neohaematopinus*, p. 403.
Pleural plates of second abdominal segment divided. Parasitic on Muridae ... ... *Polyplax*, p. 403.

11. Second sternal plate of abdomen greatly enlarged, divided medially and overlapping most of the third sternite. Parasitic on dormice ... ... *Schizophthirus*, p. 406
Second sternal plate of abdomen smaller, not divided in the middle. Parasitic on Muridae ... *Hoplopleura*, p. 406

12. Abdomen with one row of setae on each segment 13
Abdomen with more than one row of setae on each segment. Parasitic on ungulates and dog ... *Linognathus*, p. 408.

13. Setae on abdomen arranged into two dorsal and two ventral longitudinal rows; last two joints of antennae fused together. Parasitic on Procaviidae *Prolinognathus*, p. 408.
Setae on abdomen more numerous, not arranged into longitudinal rows; antennae five jointed. Parasitic on rabbits and hares ... ... *Haemodipsus*, p. 407.

Subfamily ENDERLEINELLINAE Ewing.

Genus PROENDERLEINELLUS Ewing.

Proenderleinellus Ewing, *Journ. Wash. Acad. Sci.*, XIII, No. 8, p. 148 (1923).

Bathyergicola Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 505 (1929).

This genus contains three species, two found on *Bathyergidae* (mole rats), and the third (the genotype) was recorded from *Thryonomys gregor pusillus*, Kenya Colony. This last record was undoubtedly due to straggling.

Genotype: *Proenderleinellus africanus* Ewing.

1. **Proenderleinellus hilli** (Bedford.).

Bathyergicola hilli Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 506, f. 6, 7, 7a, 8 (1929).

Described from females and males taken off Hottentot mole rat, *Cryptomys hottentotus (= Georychus hottentotus)* at Pietermaritzburg, Natal.

2. **Proenderleinellus lawrensis** (Bedford).

Bathyergicola lawrensis Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 506, f. 7b, 9, 10 (1929).

Described from females taken off Cape dune mole, *Bathyergus suillus (= B. maritimus)*, locality unknown.

Genus Enderleinellus Fahrenholz.

Enderleinellus Fahrenholz, *Zool. Anz.* XXXIX, p. 56 (1912).

Enderleinellus Ferris, Contrib. Towords a Mon. Suck. Lice, i, p. 7 (1919).

This genus is widely distributed and contains nineteen species found on Sciuridae (squirrels).

Genotype: *Enderleinellus nitzschi* Fahrenholz.

1. **Enderleinellus zonatus** Ferris.

E. zonatus Ferris, Contrib. Towards a Mon. Suck. Lice, i, p. 32, f. 18, 19 (1919).

Described from specimens taken off *Paraxerus palliatus ornatus* (Zululand squirrel), Ngoye Hills, Zululand; also from the following hosts in Kenya Colony; *Paraxerus palliatus suahelicus*, *P. jacksoni capitis* and *Parasciurus animosus*.

Subfamily HYBOPHTHIRINAE Ewing.

Genus Hybophthirus Enderlein.

Hybophthirus Enderlein, *Denks. d. Med.-Naturw. Gesell. zu Jena*, XIV, p. 79 (1909).

Hybophthirus Ferris, *Contrib. Towards a Mon. Suck. Lice*, iii, p. 175 (1922).

This genus includes a single species.

1. **Hybophthirus notophallus** (Neumann).

Haematopinus notophallus Neu., *Jahrb. des Nassausischen Ver. für Naturkunde in Wiesbaden*, p. 2 (1909).

Hybophthirus orycteropodi Enderl., *Denks. d. Med.-Naturw. Gesell. zu Jena*, XIV, p. 79, Pl. 8, f. 1-3 (1909).

Hybophthirus notophallus (Neu.) Ferris, Contrib. Towards a Mon. Suck. Lice, iii, p. 176, f. 117, 118 (1922).

Recorded by Bedford (1919) taken off Cape ant bear, *Orycteropus afer (= O. capensis)* in the Zoological Gardens at Pretoria. It was originally described from specimens taken off the same host in South-West Africa. Waterston (1914) and others have also recorded it from the same host.

Genus Scipio Cummings.

Scipio Cummings, *Bull. Ent. Res.*, III, p. 393 (1913).

Scipio Ferris, Controb. Towards a Mon. Suck. Lice, iii, p. 170 (1922).

Three species are included in this genus, two being found on Thryonomidae and one on Petromyidae.

Genotype: *Haematopinus aulacodi* Neumann.

1. **Scipio aulacodi** (Neumann).

Haematopinus aulacodi Neu., *Arch. de Parasit.*, XIV, p. 403, f. 5-7 (1911).

Scipio aulacodi (Neu.) Ferris, *Ann. Durban Mus.*, III, p. 233, f. 16, 17B (1916).

Scipio aulacodi (Neu.) Ferris, Contrib. Towards a Mon. Suck. *Lice*, iii, p. 170, f. 113, 114A, B, E, G (1922).

Recorded from *Thryonomys sp.*, Mfongosi, Zululand (Ferris), and cane rat, *T. swinderianus variegatus (= T. aulacodus)*, Rustenburg District, Transvaal (Bedford, 1919). Originally described from *T. swinderianus*, Dahomey, and Cummings (1913) has recorded it from the same host in North-eastern Rhodesia.

2. **Scipio breviceps** Ferris.

Scipio breviceps Ferris, *Ann. Durban Mus.*, III, p. 234, f. 17A, 18-22 (1916).

Scipio breviceps Ferris, Contrib. Towards a Mon. Suck. Lice, iii, p. 173, 114C, D, F, H, 115, 116 (1922).

Originally described from specimens taken off *Thryonomys sp.*, Mfongosi, Zululand. Bedford (1919) has recorded it from cane rat. *T. swinderianus variegatus (= T. aulacodus)*, Rustenburg District, Transvaal. Mr. A. Roberts informs me that *T. swinderianus variegatus* is the only species and variety found in South Africa.

3 **Scipio** nov. sp.

A ♂ taken off *Petromys typicus tropicalis* (rock rat) Windhoek. South-West Africa (Tvl. Mus. No. 5683), and a ♀ taken off " nokey " (=rock rat) without locality. A ♀ has also been taken off *Petromys nov. sp.*, Khan River, South-West Africa (coll. R. D. Bradfield).

Genus Eulinognathus Cummings.

Eulinognathus Cummings, *Ann. Mag. Nat. Hist.* (8) XVII, p. 90 (1916).

Eulinognathus Ferris, *Proc. Calif. Acad. Sci.*, vi, No. 6, p. 168, (1916).

This genus contains three species, the hosts being African Poletidae (spring hares) and Dipodidae (jerboas) and American Octodontidae.

Genotype: *Eulinognathus denticulatus* Cummings.

1. **Eulinognathus denticulatus** Cummings.

E. denticulatus Cumm., *Ann. Mag. Nat. Hist.* (8) XVII, p. 90, f. 1 (1916).

This louse is common on the springhare *(Pedetes caffer)* in South Africa.

Genus Neohaematopinus Mjöberg.

Neohaematopinus Mjöberg, *Arkiv. f. Zool.*, VI, p. 160 (1910).

Acanthopinus Mjöberg, *ibid.*, p. 160 (1910).

Linognathoides Cummings, *Bull. Ent. Res.*, III, p. 393 (1912).

Neohaematopinus Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 237 (1923).

This genus is widely distributed and includes seventeen species, the majority being found on Sciuridae (squirrels).

Genotype: *Haematopinus sciuropteri* Osborn.

1. **Neohaematopinus faurei** (Bedford).

Linognathoides faurei Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, VII & VIII, p. 710, Pl. 1, f. 2, Pl. 7, f. 3 (1920).

This louse is common on the ground squirrel *(Geosciurus capensis)* in the Orange Free State. Ingram (1927) has recorded it on *Tatera lobengulae* (gerbille) and *Mastomys coucha* (multimammate mouse), but its presence on these rodents was undoubtedly due to straggling.

2. **Neohaematopinus heliosciuri** Cummings.

N. heliosciuri Cumm., *Bull. Ent. Res.*, III, p. 393, f. i (1912).

N. heliosciuri (Cumm.) Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 255, f. 164, 165A, E, H (1923).

Described by Cummings from specimens taken off *Paraxerus (= Heliosciurus) palliatus*, Kenya Colony. Ferris (1923) also recorded it from the following hosts in Kenya Colony: *P. palliatus suahelicus*, *P. jacksoni capitis* and *Parasciurus animosus.*

3. **Neohaematopinus suahelicus** Ferris.

N. suahelicus Ferris, Contrib. Towards a Mon. Suck. Lice, IV, p. 258, f. 165B, F, G (1923).

Described from specimens taken off *Paraxerus palliatus ornatus* (Zululand squirrel), Ngoye Hills, Zululand; also from the following hosts in Kenya Colony: *P. palliatus suahelicus*, *P. jacksoni capitis* and *Parasciurus animosus.*

Genus Polyplax Enderlein.

Polyplax Enderlein, *Zool. Anz.*, XXVIII, pp. 139, 142, 223 (1904).

Polyplax Ferris, Contrib. Towards a Mon. of the Suck. Lice, iv, p. 183 (1923).

This genus is very widely distributed and comprises twenty-eight species found on Muridae (rats and mice) and two species on Sciuridae (squirrels).

Genotype: *Pediculus spinulosus* Burmeister.

1. **Polyplax arvicanthis** Bedford.

Polyplax arvicathus Bedford, *Rept. Dir. Vet. Res., Un. S. Afr.*, V & VI, p. 716, Pl. 1, f. 3, 6 (1919). (Captions of figures labelled *P. arvicanthus*).

Polyplax arvicanthis (Bedf.) Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 227, f. 148, 149 (1923).

Described from specimens taken off striped mouse, *Rhabdomys pumilio (=Arvicanthis pumilio)* at Onderstepoort. Ferris (1923) has also recorded it from *Rhabdomys pumilio diminutis*, Kenya Colony.

2. **Polyplax biseriata** Ferris.

Polyplax biseriata Ferris, Contrib. Towards a Mon Suck. Lice, iv, p. 199, f. 125A, 126 (1923).

Described from specimens taken off *Tatera bohmi varia*, Kenya Colony; also a male and female from *Tatera lobengulae* (gerbille), Bothaville, Orange Free State.

3. **Polyplax calva** Waterston.

Polyplax calva Waterston, *Parasit.*, IX, p. 199, figs. (1917).

Polyplax calva (Waterst.) Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 234, f. 153, 154 (1923).

Described from specimens taken off *Cricetomys gambianus* (giant rat) at Accra. Ferris (1923) also recorded it from varieties of the same host from Kenya Colony.

4. **Polyplax cummingsi** Ferris.

Polyplax gracilis (Fahr.) Ferris, *Ann. Durban Mus.*, I, p. 240, f. 23c, 24 (1916), *nec Fahrenholz*, 1910.

Polyplax cummingsi Ferris, *ibid.*, I, p. 240, f. 25, 26A (1916).

Polyplax cummingsi Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 213, f. 136, 137 (1923).

Described from a ♀ taken off *Dasymys incomtus*, Mfongosi, Zululand. Also recorded as *P. gracilis* from *Aethomys (= Mus) chrysophilus* (African rat) at the same locality. Bedford (1929) also recorded it taken from the latter host at Sycamore, Transvaal, and Ferris (1923) recorded it from *Dasymys incomtus helukus*, Kenya Colony.

5. **Polyplax jonesi** Kellogg and Ferris.

Polyplax jonesi Kell. & Ferris, *Ann. Durban Mus.*, I, p. 151, Pl. 15, f. 3-3e (1915).

Polyplax jonesi (K. & F.) Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 216, f. 138, 139 (1923).

Described from specimens taken off *Saccostomys campestris* (Peter's pouched mouse), Mfongosi, Zululand.

6. **Polyplax otomydis** Cummings.

Polyplax otomydis Cumm., *Bull. Ent. Res.*, III, p. 395, f. 2 (1912).

Polyplax otomydis (Cumm.) Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 211, f. 134, 135 (1923).

Described by Cummings from specimens taken off *Otomys irroratus tropicalis*, Kenya Colony. It has also been recorded taken off the following rats in South Africa: The eastern Karroo rat, *Paratomys (= Otomys) luteolus* (Waterston, 1914); the water rat, *Otomys irroratus*, Mfongosi, Zululand (Kellogg and Ferris, 1915, and Ferris, 1916) and Onderstepoort (Bedford, 1919). Ferris (1923) also recorded it from *Otomys angoniensis elassodon*, Kenya Colony.

7. **Polyplax praomydis** Bedford.

Polyplax praomydis Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 503, f. 2-5 (1929).

Described from specimens taken off *Praomys namaquensis monticularis* (rock mouse) at Onderstepoort.

8. **Polyplax spinulosa** (Burmeister).

Pediculus spinulosus Burmeister, "*Rhynchota*", *Gen. Ins.* No. 8 (1839).

Polyplax spinulosa (Burm.) Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 187, f. 119, 120A, D, F, H (1923).

This species has been recorded from *Rattus norvegicus* (type host), *Rattus rattus*, *R. rattus alexandrinus* and other species of rats in various parts of the world. It is common on *R. rattus* and *R. rattus alexandrinus* at Onderstepoort, and has also been found on *R. norvegicus (= Mus decumanus)* at Pietermaritzburg, Natal. Bedford (1929) also recorded it from *Thallomys moggi*, Onderstepoort.

It is a transmitting agent of *Trypanosoma lewisi* (Kent) to rats, but the lice do not remain infected.

9. **Polyplax waterstoni** Bedford.

Polyplax waterstoni Bedford, *Rep. Dir. Vet. Res., Un. S. Afr.*, V & VI, p. 715, Pl. 1, f. 1, 2, 4, 5 (1919).

Polyplax waterstoni (Bedf.) Ferris, Contrib. Towards a Mon. Suck. Lice, iv, p. 193, f. 121, 122 (1923).

Described from specimens taken off two species of rats at Onderstepoort. Bedford (1929) recorded it from *Mastomys coucha* (multimammate mouse) at Onderstepoort and Sycamore in the Transvaal. Ferris (1923) also recorded it from *Epimys peromyscus*, Kenya Colony.

Genus Schizophthirus Ferris.

Schizophthirus Ferris, Contrib. Towards a Mon. Suck. Lice, iii, p. 143 (1922).

This genus includes two species, one occurring on dormice (family Muscardinidae) in Europe, and the other on African dormice (family Graphiuridae).

Genotype: *Pediculus pleurophaeus* Burmeister.

1. **Schizophthirus graphiuri** Ferris.

S. graphiuri Ferris, Contrib. Towards a Mon. Suck. Lice, iii, p. 147, f. 93A, 96, 97 (1922).

Described from specimens taken off *Claviglis* (*Graphiurus*) *nanus*, Ntabamhlope, Natal; also from *Claviglis* (*Graphiurus*) *murinus isolatus* and *G. raptor*, Kenya Colony. Females from *Claviglis alticola*, Kastrol Nek, Wakkerstroom, Tvl. (Tvl. Mus. No. 2909).

Genus Hoplopleura Enderlein.

Hoplopleura Enderlein, *Zool. Anz.*, XXVIII, p. 221 ((1904).
Hoplopleura Ferris, Contrib. Towards a Mon. Sucking Lice, ii, p. 59 (1921).

This genus contains thirty-eight species found on Muridae (rats and mice), *Sciuridae* (squirrels), *Petauristidae* (flying squirrels) and Octodontidae (South American rodents).

Genotype: *Pediculus acanthopus* Burmeister.

1. **Hoplopleura affinis** (Burmeister).

Pediculus affinis Burmeister, "*Rhynchota*", *Gen. Ins.*, p. 10 (1839).

Hoplopleura affinis (Burm.) Ferris, Contrib. Towards a Mon. Suck. Lice, ii, p. 75, f. 42, 43 (1921).

Recorded by Bedford (1929) taken off *Thallomys moggi* (Mogg's rat) at Onderstepoort. Originally described from specimens taken off a rat in Europe. Ferris (1921) recorded it from various rats in Europe, Asia and South America.

2. **Hoplopleura biseriata** Ferris.

H. biseriata Ferris, Contrib. Towards a Mon. Suck. Lice, ii, p. 103, f. 64A (1921).

Described from a ♀ taken off typical long-eared mouse, *Malacothrix typicus typicus* (= *Malacothrix sp.*), Bothaville, Orange Free State. Bedford (1929) recorded it from *Tatera* (=*Tateroma*) *angolae*, South-West Africa. Specimens have also been taken off *Tatera lobengulae* near Ramathlabama, Bechuanaland Protectorate (sent by B. de Meillon).

3. **Hoplopleura enormis ernormis** Kellogg and Ferris.

H. enormis Kell. & Ferris, *Ann. Durban Mus.*, I, p 155, Pl. 16, f. 4-4e (1915).

H. enormis (Kell. & Ferris) Ferris, Contrib. Towards a Mon. Suck. Lice, ii, p. 94, f. 57, 58B-C, 59B (1921)

Described from specimens taken off bushveld striped mouse, *Lemniscomys spinalis (=Arvicanthis dorsalis)*, Mfongosi, Zululand. Bedford (1929) recorded it taken off the same host at Sycamore, Transvaal. Ferris (1921) also recorded it from *Lemniscomys barbatus zebra*, Gondokoro, Africa.

4. **Hoplopleura intermedia** Kellogg and Ferris.

H. intermedia Kell. & Ferris, *Ann. Durban Mus.*, I, p. 153, Pl. 16, f. 5-5D (1915).

H. intermedia (Kell. & Ferris) Ferris, Contrib. Towards a Mon. Suck. Lice, ii, p. 90, f. 54, 55B-D, 56B (1921).

Described from specimens taken off multimammate mouse, *Mastomys coucha (= Mus coucha)* Mfongosi, Zululand. It has also been taken off the same host at Onderstepoort. Ferris (1921) recorded it from the following hosts in Kenya Colony: *Dendromys mesomelas insignis*, *Rattus tullbergi peromyscus* and *Zelotomys hildegardae*.

Subfamily NEOLINOGNATHINAE Ewing.

Genus Neolinognathus Bedford.

Neolinognathus Bedford, *Ent. Mont. Mag.* (3), VI, p. 88 (1920).

Neolinognathus Ferris, Contrib. Towards Mon. Suck. Lice, iii, p. 166 (1922).

This genus contains two described species found on Macroscelidae (elephant shrews), of which one has been recorded from the Union.

Genotype: *Neolinognathus elephantuli* Bedford.

1. **Neolinognathus elephantuli** Bedford.

N. elephantuli Bedford, *Ent. Mont. Mag.* (3), VI, p. 89, f. 1, 2 (1920).

N. elephantuli (Bedford) Ferris, Contrib. Towards Mon. Suck. Lice, iii, p. 166, f. 110, 111A-C, F (1922).

Originally described from females and males taken off Jameson's rock shrew, *Elephantulus myurus jamesoni (= E. rupestris jamesoni)* at Onderstepoort. Ferris (1922) has also recorded it from *Petrodromus tetradactylus*, Nyasaland, and *Nasilio brachyrhynchus delameri*, Kenya Colony.

Subfamily LINOGNATHINAE Enderlein

Genus Haemodipsus Enderlein.

Haemodipsus Enderlein, *Zool. Anz.*, XXVIII, pp. 139, 143 (1904).

Haematopinus (*Polyplax*) Neumann, *Arch. de Parasit.*, XIII, p. 536 (1909).

This genus comprises two species found on Leporidae (hares and rabbits).

Genotype: *Pediculus lyriocephalus* Burmeister.

1. **Haemodipsus ventricosus** (Denny).

Haematopinus ventricosus Denny, Mon. Anoplur. Brit., p. 30, Pl. 25, f. 6 (1842).

Haemodipsus ventricosus (Denny) Kell. & Ferris, Anoplur. & Mall. N. Am. Mam., p. 28, f. 11; Pl. 2, f. 2; Pl. 4, f. 5; Pl. 5, f. 12 (1915).

Occurs on the domestic rabbit, but is not very common in South Africa. It has also been recorded from *Lepus spp.* in the United States.

Genus Prolinognathus Ewing.

Prolinognathus Ewing, A Manual of Extern. Parasites, pp. 136. 201 (1929).

This genus includes two species found on Procaviidae (dassies).

Genotype: *Pediculus caviae-capensis* Pallas.

1. **Prolinognathus caviae-capensis** (Pallas).

Pediculus caviae-capensis Pallas, *Spicilegia Zool.*, XII, p. 32, Pl. 3, f. 12, 13 (1767).

Linognathus caviae-capensis (Pallas) Cummings, *Bull. Ent. Res.*, IV, p. 37, f. 2, 3 (1913).

Described by Pallas from specimens taken off Cape dassie, *Procavia capensis* (Pallas). Specimens have also been taken off *Procavia sp.*, Lamberts Bay, C.P. (Tvl. Mus. No. 2148); *Procavia sp.*, Mtabamhlope, Natal; *Procavia coombsi* at Onderstepoort and in the Rustenburg District, Transvaal; *Heterohyrax ruddi*, Macequece, Portuguese East Africa (Tvl. Mus. No. 6215), and *Procavia waterbergensis*, Otjiwarango, South-West Africa (Tvl. Mus. No. 5335).

Genus Linognathus Enderlein.

Trichaulus Enderl., *Zool., Anz.*, XXVII, pp. 139, 141 (1904).

Linognathus Enderl., *ibid.*, XXIX, p. 194 (1905).

This genus comprises about twenty-one species found on Bovidae, llamas and domestic dog.

Genotype: *Pediculus piliferus* Burmeister = *Pediculus setosus* Von Olfers.

1. **Linognathus africanus** Kellogg and Paine.

L. africanus Kell. & Paine, *Bull. Ent. Res.*, II, p. 146, Pl. 4, f. 1, 5 (1911).

Specimens have been taken off sheep at Kuruman, Cape Province. Also off sheep at Salisbury, S. Rhodesia and off a boer goat at Onderstepoort. It was originally described from specimens taken off sheep in Southern Nigeria.

2. **Linognathus angulatus** (Piaget).

Haematopinus angulatus Piaget, *Les Pédiculines*, Suppl., p. 144, Pl. 15, f. 7 (1885).

Recorded by Ferris (1916) and Bedford (1919) taken off *Cephalophus natalensis* (red duiker), Mfongosi, Zululand. Specimens have also been taken off *Sylvicapra grimmi transvaalensis* (Transvaal duiker), Rustenburg District, Transvaal, and *Philantomba monticola* (blue duiker), Pietermaritzburg, Natal (coll. L. Hill). It was originally described from *Cephalophus nigrifrons*.

3. **Linognathus brevicornis** (Giebel).

Haematopinus brevicornis Giebel, *Ins. Epiz.*, p. 43 (1874).

Described from specimens taken off *Giraffa camelopardalis*.

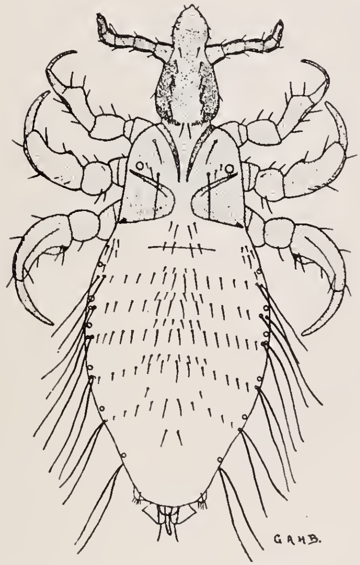


Fig. 15. *Linognathus gnu* Bedford, male.

4. **Linognathus fahrenholzi** Paine.

Linognathus forficulus Kell. & Paine, *Bull. Ent. Res.*, II, p. 147, Pl. 4, f. 2-4 (1911), *nec* Rudow, 1869.

Linognathus fahrenholzi Paine, *Psyche*, XXI, p. 117 (1914).

Recorded by Ferris (1916) and Bedford (1919) taken off *Redunca fulvorufula* (mountain reedbuck), Mfongosi, Zululand. It was originally described from specimens taken off *Redunca arundinum* (reedbuck) in Nyasaland.

5. **Linognathus** nov. sp.

♀ ♀ and ♂ taken off *Tragelaphus sylvaticus* (bushbuck) at Onderstepoort.

6. **Linognathus gnu** Bedford (Fig. 15).

Linognathus gnu, Bedford, *Trans. Roy. Soc. S. Afr.*, p. 349, f. 3, 4 (1927).

Linognathus ferrisi Bedford, *ibid.*, p. 351, f. 5, 6 (1927), *nec* Fahrenholz, 1919.

Linognathus gorgonus Bedford, *Ann. Rep. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 502 (1929).

L. gnu was described from a female taken off *Connochaetes gnu* (black wildebeest) at Clocolan, O.F.S., and *L. ferrisi* from a male taken off *Gorgon taurinus* (blue wildebeest), Zoutpansberg District, northern Transvaal. Both sexes have since been taken off *G. taurinus* at Maasstroom, northern Transvaal and in the Zoological Gardens, Pretoria.

7 **Linognathus pedalis** (Osborn).

Haematopinus pedalis Osborn, *Bull. 5 n.s., U.S. Dept. Agr., Div. Ent.*, p. 170, f. 99 (1896).

Haematopinus ovis Lugger. *Rept. Ent. State Exper. Stat., Minnesota*, p. 105, f. 75, 76 (1896).

Specimens have been received on two or three occasions taken off sheep in different parts of the Union. This species is usually found on the legs of its host.

8. **Linognathus setosus** (Von Olfers).

Pediculus setosus V. Olfers, De Vegetat. et Anim. Corpor. in Corpor. Anim. Reper. Comm., I (1816).

Pediculus piliferus Burmeister, Gen. Rhyn., No. 13 (1838).

Waterston (1914) has recorded this species taken off a dog at Capetown, and Bedford (1919) from a dog at Onderstepoort. Fernandes has also recorded it from a dog in Mozambique.

9. **Linognathus stenopsis** (Burmeister).

Pediculus stenopsis Burmeister, Gen. Rhyn., No. 3 (1838).

Pediculus saccatus Gervais, *Apterés*, III, p. 307 (1847).

Pediculus schistopygus Nitzsch, *Zeit. f. ges. Nat.*, XXIII, p. 31 (1864).

Haematopinus forficulus Rudow, *ibid.*, XXXIV, p. 169 (1869).

Haematopinus rupicaprae Rudow, *ibid.*, XXXIV, p. 170 (1869).

This species is a parasite of goats, but is not common in South Africa.

10. **Linognathus tibialis** (Piaget).

Haematopinus tibialis Piaget, *Les Pédiculines*, p. 646, Pl. 52, f. 8 (1880).

Linognathus tibialis var. euchore Waterston, *Ann. S. Afr. Mus.*, X, ix, p. 275, f. 1 (1914).

Recorded by Waterston (1914) from springbok, *Antidorcas marsupialis (= Antilope euchore).* Specimens have been taken off the same host at Onderstepoort.

11. **Linognathus taurotragus** Bedford.

Linognathus taurotragus Bedford, *Trans. Roy. Soc. S. Afr.*, XIV, iv, p. 347, f. 1, 2 (1927).

Described from specimens taken off *Taurotragus oryx* (eland) at Clocolan, O.F.S., August, 1920.

12. **Linognathus vituli** (Linnaeus).

Pediculus vituli Linné, *Syst. Natur.*, *ed.* X, p. 611 (1758).

Pediculus tenuirostris Burmeister, Gen. Rhyn., No. 17 (1838).

Pediculus oxyrrynchus Nitzsch, *Zeit. f. ges. Nat.*, XXIII, p. 21 (1864).

This species is a common parasite on cattle, especially calves, in the Union. Bedford (1929) recorded an immature specimen found on a fly, *Musca lasiophthalma*, at Camps Bay, Capetown.

Subfamily HAEMATOPININAE Enderlein.

Genus HAEMATOPINUS Leach.

Haematopinus Leach. Zool. Misc., III, p. 64, f. 146 (1817).

This genus comprises about ten species found on ungulates.

Genotype: *Pediculus suis* Linnaeus.

1. **Haematopinus asini** (Linnaeus).

Pediculus asini Linné, *Syst. Natur.*, *ed.* X, p. 612 (1755).

Pediculus macrocephalus Burmeister, *Gen. Rhyn.*, No. 18 (1838).

This species is common on horses, donkeys and mules in South Africa. Fernandes has recorded it from horses and mules in Mozambique, and Piaget (1880) from *Hippotigris burchelli* (Burchell's zebra) in the Zoological Museum, Hamburg.

2. **Haematopinus bufali** (De Geer).

Pediculus bufali De Geer, *Hist. de Ins.*, VII, p. 68, Pl. 1, f. 11, 12 (1778).

Pediculus phthiriopsis Gervais, Apterès, III, p. 306 (1844).

Recorded from *Syncerus caffer* (African buffalo) in the Belgian Congo and Nyasaland. Specimens have been taken off the same host from N. Transvaal in the Zoological Gardens, Johannesburg (coll. G. Martinaglia).

3. **Haematopinus eurysternus** (Nitzsch).

Pediculus eurysternus Nitzsch., *Germar's Magazin*, III, p. 305 (1818).

A common species on cattle in the Union and Mozambique.

4. **Haematopinus latus** Neumann.

Haematopinus latus Neu., *Arch. d. Parasit.*, XIII, p. 505, f. 6-9 (1909).

Haematopinus incisus Harms, *Zool. Anz.*, p. 290 (1912).

Specimens have been taken off *Koiropotamus choeropotamus* (bush-pig), Kleinpoort, Albany District, C.P. (sent by J. Hewitt; coll. W. Pannell). Ferris (1916) has recorded it from the same host, Ngxwala Hill, Ubombo, Zululand. It was originally described from specimens taken off *Potamochoerus africanus* in Nyasaland. *H. incisus* was described from specimens taken off *Potamochoerus sp.*

5. **Haematopinus phachochoeri** Enderlein.

Haematopinus phachochoeri Enderl., *Schwed. Exp. Kilimanjaro*, II, p. 7, fig. (1908).

Haematopinus peristictus Kell. & Paine, *Bull. Ent. Res.*, II, p. 145, Pl. 4, f. 3, 6 (1911).

This species is common on the Natal warthog *(Phachochoerus sundevalli)* in Zululand and on the West African warthog *(Phachochoerus aethiopicus)* in the Transvaal. It was originally described from specimens taken off *P. oeliani massaicus*, and has also been recorded from *P. affinis nyasae*. We have also received specimens reported to have been taken off *Koiropotamus choeropotamus* (bush pig) in South-West Africa.

6. **Haematopinus suis** (Linnaeus).

Pediculus urius Moufet, *Theatrum Ins.*, p. 266 (1634).

Pediculus suis Linné, *Syst. Natur*, ed. X, p. 611 (1758).

This species is common on domestic pigs in the Union and Mozambique.

7. **Haematopinus taurotragi** Cummings.

H. taurotragi Cumm., *Bull. Ent. Res.*, V, p. 155, f. 1, 2 (1914).

This species was described from specimens taken off an eland *(Taurotragus oryx)* in the Knowsby Managerie in 1857. Specimens have been received taken off the same host in the Drakensberg Game Reserve, Natal, and from a Koodoo *(Strepsiceros strepsiceros)*, Grahamstown, C.P.

Family PEDICULIDAE Leach.

This family contains about thirteen species found on primates. It is interesting to note that the parasites of the higher apes are more closely related to the parasite of man than they are to the parasites of monkeys.

Key to the Subfamilies and S. African Genera.

1. Fore legs much smaller than mid and hind legs; eyes wanting (vestigial in one exotic genus). Parasitic on lemurs Subfamily PHTHIRPEDICULINAE ... *Lemurphthirus.*

Legs subequal, except in the male; the fore legs are sometimes more dilated than the others; eyes well developed Subfamily PEDICULINAE, 2

2. Abdomen with three pairs of pleurites; antennae 3- or obscurely 5-segmented. Parasitic on monkeys *Pedicinus.*

Abdomen with seven pairs of pleurites; antennae longer, distinctly 5-segmented. Parasitic on man and apes *Pediculus.*

Subfamily PHTHIRPEDICULINAE.

This subfamily includes two species. They should probably be placed in a separate family.

Genus LEMURPHTHIRUS Bedford.

Lemurphthirus Bedford, *Parasit.*, XIX, ii, p. 263 (1927).

This genus contains a single species.

1. **Lemurphthirus galagus** Bedford.

♀. *Lemurphthirus galagus* Bedford, *Parasit.*, XIX, ii, p. 263, f. 1, 2 (1927).

♂. *Lemurphthirus galagus* Bedford, *Ann. Rept. Dir. Vet. Serv., Un. S. Afr.*, XV, p. 501, f. 1 (1929).

Described from specimens taken off *Galago moholi* (Moholi night ape), Onderstepoort and South-West Africa.

Subfamily PEDICULINAE.

Genus PEDICINUS Gervais.

Pedicinus Gervais, *Apterès*, III, p. 301, Pl. 48, f. 1 (1844).

This genus includes five species found on monkeys.

Genotype: *Pediculus eurygaster* Burmeister.

1. **Pedicinus hamadryas** Mjöberg.

Pedicinus hamadryas Mjöberg, *Arkiv. f. Zool.*, VI, p. 172, f. 86, 87 (1910).

Described from specimens taken off *Papio sp.* (?) in the Zoological Museum, Hamburg. Specimens have been taken off *Papio griseipes* (chagma baboon) at Mooivlei, Transvaal, and at Mtabamhlope, Natal. (Det. by G. F. Ferris, who has compared them with the type.)

2. **Pedicinus longiceps** Piaget.

Pedicinus longiceps Piaget, *Pédiculines*, p. 632, Pl. 51, f. 7 (1880).

Specimens have been taken off *Cercopithecus aethiops* (vervet monkey) in the Rustenburg District, Transvaal, and at Nongoma, Zululand (det. by G. F. Ferris, who has compared them with the types taken off *Semnopithecus pruinosus* and *Cercopithecus cynomolgus*).

Genus Pediculus Linnaeus.

Pediculus Linné, *Syst. Natur.*, ed. X, p. 610 (1758).

This genus contains about six species parasitic on man and apes.

Genotype: *Pediculus humanus* Linnaeus.

1. **Pediculus humanus humanus** Linnaeus.

Pediculus humanus Linnaeus, *Syst. Nat.*, ed. X, p. 610 (1758).

P. humanus var. corporis De Geer, *Mem. Hist. Ins.*, VII, p. 67, Pl. 1, f. 7 (1778).

P. capitis Nitzsch, *Germar's Mag.*, III, p. 305 (1818).

P. vestimenti Nitzsch, *ibid.*, III, p. 305 (1818).

P. humanus (L.) Keilin & Nutt., *Parasit.*, XXII, i, pp. 1-10, Pl. 1-18 (1930).

For complete bibliography of this species see Nuttall (1917a). It is a common parasite of man in South Africa, being found on both the head and body of its host. The head lice *(humanus)* are smaller and more chitinous than body lice *(corporis)*. Both Howlett (1917) and Keilin and Nuttall (1919) have demonstrated that typical *humanus (= capitis)* may be transformed experimentally after one or two generations into typical *corporis*, proving that they can only be recognized as distinct races. Ewing (p. 161, 1926) described the *var. nigritarum* Fabr. from an African negro, but did not compare it with the race *corporis*. The biology of this species has been worked out by Nuttall (1917 b). It has been proved to transmit typhus fever *(Rickettsia prowazeki)*, trench fever *(Rickettsia quintana)* and relapsing fever *(Treponema obermeieri)* to man. For combating lousiness among soldiers and civilians see Nuttall (1918).

Family PHTHIRIDAE Ewing.

Genus Phthirus Leach.

Phthirus Leach, *Edinburgh Encycl.*, IX, p. 77 (1815).

Phthirius Burmeister, Handb. der Ent., II, p. 1 (1835).

This genus contains two species, one parasitic on man and the other on gorilla.

Genotype: *Pediculus pubis* Linné.

1. **Phthirus pubis** (Linnaeus).

Pediculus pubis Linnaeus, Syst. Natur., ed. X, p. 611 (1758).

Phthirus inguinalis Leach, Edinburgh Encycl., IX, p. 77 (1817).

Phthirius pubis (L.) Piaget, *Pédiculines*, p. 628, Pl. 51, f. 5 (1880).

For complete bibliography of this species see Nuttall (1917a). It is known as the "crab louse" and is a common parasite on man in South Africa. The biology of this species has been worked out by Nuttall (1918). It is not known to transmit disease.

Order HEMIPTERA (= RHYNCHOTA).

This order contains a very large number of insects called bugs, etc. The majority of the species live on plants. All those that have been found to be parasitic on mammals and birds in South Africa belong to the family Cimicidae.

Suborder HETEROPTERA.

Family CIMICIDAE.

Species ovoid and flattened; the head is short and broad; the rostrum lies in a groove on the ventral surface of the head and thorax; the hemelytra are very short, leaving most or all of the abdomen uncovered; ocelli absent; tarsi three-jointed. Metamorphosis incomplete, the young resembling the adults.

Genus Cimex Linnaeus.

Body covered with fine, short setae, the lateral ones on pronotum shorter than the first segment of the antennae; antennae four-jointed, the apical joints slender. Prothorax semilunar in shape with its anterior angles considerably extended; the hemelytra lie over the metathorax. Legs slender, anterior tibiae more than twice as long, and the posterior tibiae three times as long, as the tarsi.

This genus includes the bed-bugs. They are nocturnal in habits, hiding by day in crevices of wood-work, etc., where they deposit their ova. The ova take about four to eight days, or longer, to hatch. There is one larval stage and three nymphal stages. The period from larva to adult takes about six to seven weeks during hot weather, and from nine to eleven weeks in cold weather. Egg-laying commences ten to fourteen days after the adult stage is reached.

1. **Cimex columbarius.**

This species has been found in a fowl-house at Arum Valley, Krags Post, O.F.S. (Det. K. Jordan), and also in fowl-houses in the Pretoria District. In Europe it has also been found to be parasitic on domestic pigeons. It is most probably a synonym of *C. lectularius*, as has been suggested to me by Dr. Jordan.

2. **Cimex lectularius** Linné.

This species, known as the "bed bug", is a common parasite of man in South Africa. It has also been recorded from other parts of Africa, and from Europe, Asia and North America. Chatton and Blanc (1918) state that they have found this species to exist where only small rodents and cats could have supplied meals of blood. It is very closely allied to *C. hemipterus* (Fabr.) (Syn. *C. rotundatus* Signoret), a common tropical and sub-tropical bug, which probably also occurs in South Africa. For differences between the two species, see Patton and Cragg (1913).

3. **Cimex pipistrelli** Jenyns.

This species has been recorded found on bats in Europe, and also from a bat at Capetown. Pringault (1914) has proved this species to be transmitting agent of *Trypanosoma vespertilionis*.

Genus Cacodmus Stål.

Cacodmus Stål, *Enumeratio Hemipt*, p. 103 (1873).

Body covered with long setae, most of the lateral ones on pronotum longer than the first segment of the antennae; antennae four-jointed, the apical joints slender. Tibiae without pseudo-joints. Second segment of proboscis longer than fourth. This genus contains three species parasitic on bats in Africa.

Genotype: *Acanthia villosa* Stål.

1. **Cacodmus sparsilis** Rothschild.

C. villosus (Stål) Roths., *Ent. Mo. Mag.* (2) XXIII, p. 82 (1912) Partim.

C. villosus (Stål) Roths., *Ibid.*, (2) XXIV, p. 102 (1913) Partim.

C. sparsilis Roths., *Bull. Ent. Res.*, V, i, p. 41, f. 3 (1914).

Described from a female in the British Museum taken off Zulu great house bat, *Scotophilus nigrita dingani (= Vespertilio dingani)* at Durban, Natal.

2. **Cacodmus villosus** (Stål).

Acanthiavillosa Stål, *Öfr. Kongl. Svenska Vet. Akad. Forh.*, XII, p. 38 (1855).

C. villosus (Stål) Roths., *Ent. Mo. Mag.* (2) XXIII, p. 82 (1912) Partim.

C. villosus (Stål) Roths., *ibid.*, (2) XXIV, p. 102 (1913) Partim.

C. villosus (Stål) Roths., *Bull. Ent. Res.*, V, i, p. 41, f. 1, 4 (1914)

Recorded by Rothschild (1913) taken off *Eptesicus capensis* (Cape house bat) in South Africa. Bequaert (Rep. Harvard Afr. Exp. Rep. of Liberia and Belg. Congo, p. 823, 1930) records a male from *Pipistrellus musciculus* Thomas, Belgian Congo.

Order DIPTERA.

DIPTERA PUPIPARA.

Family HIPPOBOSCIDAE.

The flies included in this family are parasitic upon mammals and birds. They are flattened dorso-ventrally and may have a tough leathery integument. The head is sunk into an emargination of the thorax. Eyes present; ocelli present or absent. The palpi form a sheath to the proboscis. The antennae, which are inserted in a

depression, are two to three-jointed, with an arista which is always dorsal. Legs short and stout; claws strong and often toothed. Wings present or absent; some species shed their wings when they get on to a host. The females give birth at intervals to single larvae, which are unsegmented, whitish in colour, with a black cap at the posterior end which involves the spiracles. They are immobile, and after a few hours become either brown or black and transform into puparia. The head and mouth parts have been described by Jobling (Parasit., XVIII, pp. 319-349, 1926).

Key to the South African Genera.

1. Wings well developed and functional 2
   Wings rudimentary or wanting 9
2. Claws with the usual two points (heel and tip). Parasitic on mammals and ostriches 3
   Claws with three teeth. Parasitic on birds 5
3. Head of normal form, not broadly impinging on the thorax, freely movable; ocelli absent; wings always present *Hippobosca*, p. 418.
   Head flat, broadly impinging on the thorax; wings usually becoming detached, leaving only a shred 4
4. Ocelli absent; palpi rudimentary or absent *Echestypus*, p. 420.
   Ocelli present; palpi well developed ... *Lipoptena*, p. 420.
5. Wings with the "second vein" (R2 and 3) confluent with costa slightly beyond tip of "first vein" (R1); three "cross veins" present; ocelli present *Ornitheza*, p. 421.
   Wings with neither the "second vein" (R2 and 3) nor "third vein" (R4 and 5) confluent with costa 6
6. Ocelli present (absent in male of *inocellata*); wings with three "cross veins", and therefore with an anal cell *Ornithomyia*, p. 422.
   Ocelli absent; wings with one or two "cross veins" 7
7. Scutellum with finger-like processes at the latero-posterior angles; wings with one "cross vein"; anal cell absent *Pseudolynchia*, p. 423.
   Scutellum without finger-like processes; wings with two "cross veins" 8
8. Clypeus much longer than broad, emarginated in front and hiding base of rostrum ... ... *Olfersia*, p. 423.
   Clypeus short, broadly emarginated in front, not hiding base of rostrum ... ... *Lynchia*, p. 424.
9. Wings either present or broken off at the bases; if present rudimentary and functionless; halteres present 10
   Wings vestigial, minute; halteres absent *Melophagus*, p. 421.

10. Claws with the usual two points (heel and tip) 11
Claws with three teeth 12

11. Ocelli absent; palpi rudimentary or absent *Echestypus*, p. 420.
Ocelli present; palpi well developed ... ... *Lipoptena*, p. 420.

12. Ocelli present or absent; wings entirely narrow and ribbon-like ... ... *Stenepteryx*, p. 426.
Ocelli absent; wings usually extending beyond tip of abdomen, and except in one or two species in which they are blunt or abbreviated, pointed or attenuate at the tips, in several cases approximately the distal third being narrow and ribbon-like ... ..., *Crataerina*, p. 425.

Genus Hippobosca Linné.

Hippobosca Linné, *Fauna Suecica*, Ed. II, p. 471 (1761).

Hippobosca Ferris, *Philip. Journ. Sci.*, XLIII, iv, p. 537 (1930).

Genotype: *Hippobosca equina* Linné.

Bequaert (1930) gives a key to the eight known species.

1. **Hippobosca capensis** Von Olfers.

Hippobosca capensis V. Olfers, "*De Vegetavis et Animatis Corporibus in Corpor. Anim. Reper. Comm.*", I, p. 101 (1816).

Hippobosca francilloni Leach, *Gen. Spec. Eprobosci. Ins.*, p. 8, Pl. 26, f. 8-10 (1817).

Hippobosca canina Rondani, *Ann. Mus. Civ. Genova*, XII, p. 164 (1878).

In the laboratory collection there are seven specimens taken off dogs in the Marico District, Western Transvaal (coll. E. M. Robinson); also two specimens taken off the same animals in the Cape Province.

2. **Hippobosca equina** Linné.

Hippobosca equina Linné, *Syst. Nat.*, Ed. 10, I, p. 607 (1758).

Hippobosca taurina Rondani, *Bull. Soc. Ent. Ital., Firenze*, XI, p. 25 (1879).

Hippobosca equina (L.) Austen , Illust. Brit. Blood-suck. Flies, p. 63, Pl. 31 (1906).

Hippobosca equina (L.) Massonat, *Ann. de l'Univ. de Lyon* (nouv. série) 1 Fasc. XXVIII, p. 235, f. 1-5 (1909).

Hippobosca equina (L.) Ferris, *Philip. Journ. Sci.*, XLIII, iv, p. 539, figs. (1930).

This species is parasitic upon horses and cattle in Europe. Austen (1909) states that there are specimens in the British Museum from the Cape of Good Hope, Algeria, Madeira, etc.

3. **Hippobosca maculata** Leach.

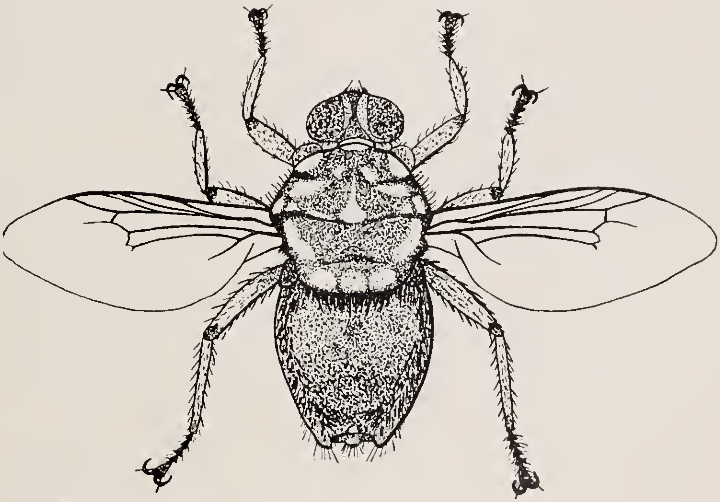
Hippobosca maculata Leach, " *Gen. Spec. Eproboscі. Ins.*", p. 7, Pl. 26, f. 1-3 (1817).

Hippobosca maculata (Leach) Austen, Illust. Afr. Bloodsuck. Flies, p. 173, Pl. 13, f. 99 (1909).

Hippobosca maculata (Leach). Stekhoven, *Die Bloedzuig. Arthro. van Nederl. Oost Ind.*, I-II, p. 1, figs. (1923).

Hippobosca maculata (Leach) Ferris, *Philip. Journ. Sc.*, XLIII, iv, p. 544, figs. (1930).

This species is widely distributed in Africa, and also occurs in Europe, India, Ceylon and the East Indies. It is mainly parasitic upon cattle, but also attacks horses. Austen (1909) has recorded it from Lourenco Marques, and Howard (1912) states that it is common everywhere in Mozambique. In the laboratory collection there is one specimen labelled " Barberton, Transvaal, March, 1909 ".



A. B. M. Whitnall del.

Fig. 16. *Hippobosca rufipes* Von Olfers.

4. **Hippobosca rufipes** Von Olfers (Fig. 16).

Hippobosca rufipes v. Olfers, *De Vegetatives Animatis Corporibus in Corpor. Anim. Rep. Comm.*, 1, p. 101 (1816).

Hippobosca rufipes (Von Olfers) Austen, Illust. Afr. Bloodsuck. Flies, p. 176, Pl. 13, f. 100 (1909).

A very common parasite on cattle and horses in many parts of the Cape Province, Orange Free State, Transvaal, Natal and South-West Africa. It also occurs in Zululand, but is by no means common in that country. It is mainly found in arid country. We have frequently observed this fly to settle on man,

but it is doubtful whether they ever attempt to bite. They have also been observed, on one or two occasions, to settle on dogs and we have taken it on *Gorgon taurinus* (blue wildebeest) in the Waterberg District, Northern Transvaal.

5. **Hippobosca struthionis** Janson.

Hippobosca struthionis Janson in Ormerod, *Not. and Descript. of a few Injur. Farm and Fruit Insects of S. Afr.*, p. 56, f. 23 (1889).

Hippobosca struthionis (Janson) Austen, Illust. Afr. Blood-suck. Flies, p. 171, Pl. 13, f. 98 (1909).

This fly is a common parasite on ostriches in the Cape Province. On two occasions specimens have settled on me when motoring in different parts of the Cape Province, and I also took a specimen on myself in the Waterberg District, Northern Transvaal, on the 9th September, 1924.

Genus Lipoptena Nitzsch.

Lipoptena (Nitzsch) Ferris and Cole, *Parasit.*, XIV, ii, p. 180 (1922).

This genus comprises about a dozen species found on *Cervidae, Tragulidae* and *Bovidae in* Europe, Asia and America.

Genotype: *Pediculus cervi* Linné.

1. **Lipoptena cervi** (Linné).

Lipoptena cervi Austen, Illust. Brit. Blood-suck. Flies, p. 65, Pls. 33, 34, f. 1 (1906).

Lipoptena cervi (L.) Ferris and Cole, *Parasit.*, XIV, ii, p. 189, f. 5 (1922).

Austen (1906) records a specimen of this species taken in February, 1901, near Johannesburg, Transvaal, under circumstances pointing to the possibility that it had been introduced into South Africa with remounts during the Anglo-Boer War. It is a parasite of several species of deer in Europe.

2. **Lipoptena capensis** Walker.

Austen (1909) records this species in his list of blood-sucking Diptera found in Natal.

Genus Echestypus Speiser.

Echestypus Speiser, *Denkschr. med.-naturw. Ges.*, Jena XIII, p. 176 (1908).

This genus contains five described species.

1. **Echestypus binoculus** Speiser.

Echestypus binoculus Speiser, *Denkschr. med.-naturw. Ges.*, Jena, XIII, p. 176 (1908).

Described from specimens taken off *Raphiceros campestris* (steenbok) in South Africa. In the British Museum there are one female and one male taken off *Antidorcas marsupialis* (springbok) near Middelburg, C.P., May, 1910.

2. **Echestypus paradoxus** (Newstead).

Lipoptena paradoxus Newstead, *Ann. Trop. Med. & Parasit.*, 1, p. 91, f. 19, 20 (1907).

Echestypus paradoxus (Newstead) Ferris, *Parasit.*, XXII, iii, p. 278, f. 3, 4 (1930).

Described from females taken off an antelope at Kasongo, Belgian Congo.

In the laboratory collection there are numerous specimens taken off the following hosts: *Strepsiceros strepsiceros* (Cape koodoo) in the Pietersburg District, Transvaal, 2 August, 1913, and Zululand, 17 March, 1916 (coll. D. T. Mitchell); *Nyala angasi* (nyala) in the Ubombo Flats, Zululand, February, 1916 (coll. D. T. Mitchell); *Tragelaphus sylvaticus* Sparrm. (bushbuck) at Ntambanana, Zululand (coll. G.A.H.B.), Bechuanaland Protectorate (coll. B. De Meillon) and in Sekukuniland; *Redunca arundinum* Bodd. (reedbuck) at Emakosini, northern Zululand (coll. G.A.H.B.); *Sylviacarpra grimmi* (duiker), Umfolosi, Zululand. Recorded in error by me from *Redunca fulvorufula* Afz. (mountain reedbuck).

3. **Echestypus sepiaceus** (Speiser).

Lipoptena sepiaceus Speiser, *Zeitschr. f. Hym. u. Dipt.*, V, p. 353 (1905).

Austen (1909) records this species in his list of blood-sucking Diptera found in the Cape Province.

Genus Melophagus Latreille, 1804.

This genus contains a single species and two varieties.

1. **Melophagus ovinus** Linnaeus.

Melophagus ovinus (Linné) Austen, Illust. Brit. Blood-suck. Flies, p. 67, Pl. 34, f. 2 (1906).

Melophagus ovinus ovinus (Linné) Ferris & Cole, *Parasit.*, XIV, ii, p. 192, f. 8, 9 A-D (1922).

This species, known as the "sheep ked", is widely distributed throughout the world. It is a common parasite on sheep in South Africa, and is the transmitting agent of *Trypanosoma melophagium* Flu, which is non-pathogenic to sheep.

Genus Ornitheza Speiser.

Ornitheza Speiser, *Termes. Fuzet*, Budapest, XXV, p. 329 (1902).

Ornitheza (Speiser) Ferris, *Philip. Journ. Sci*, XXVII, iii, p. 418 (1925).

1. **Ornitheza metallica** (Schiner) Fig. 17.

♀. *Ornitheza metallica* (Sch.) Ferris, *Phil. Journ. Sci.*, XXVII, iii, p. 419, f. 4, 5 (1925).

♂. *Ornitheza metallica* (Sch.) Ferris, *ibid.*, XXXIV, ii, p. 213, f. 6 (1927).

One ♀ taken off *Urocolius indicus transvaalensis* (Transvaal red-faced coly) at Onderstepoort. In this species the wings have an extra anal vein, the "third anal".

Genus Ornithomyia Latreille.

Ornithomyia Ferris, *Philip. Journ. Sci.*, XXXIV, ii, p. 211 (1927).
Genotype: *Hippobosca avicularia* Linné.

1. **Ornithomyia inocellata** Ferris (Fig. 18).

Ornithomyia inocellata Ferris, *Parasit.*, XXII, iii, p. 275 (1930).

Described from specimens taken off *Petrochelidon spilodera* Sund. (South African cliff swallow) at Onderstepoort.

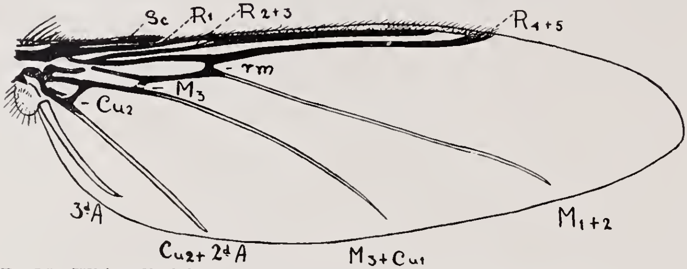


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Fig. 17. Wing of *Ornitheza metallica* (Sch.).

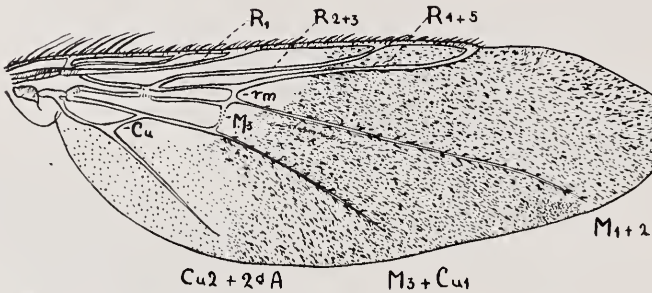

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Fig. 18. Wing of *Ornithomyia inocellata* Ferris.

2. **Ornithomyia platycera** Macquart.

Ornithomyia platycera Macq., *Mem. Soc. Roy. des Sc. del'Agric. et des Arts de Lille*, p. 436 (1843).

In the British Museum collection there are five specimens:—One from the Cape of Good Hope off *Oreocincla*, one from Natal, one from Central Africa, one from Kenya Colony, and one from Uganda off waterbuck.

3. **Ornithomyia fur** Schin.

4. **Ornithomyia laticornis** Macquart.

Austen (1909) records the last two species in his list of blood-sucking Diptera found in the Cape Province.

Genus Pseudolynchia Bequaert.

Lynchia (Weyenberg) Ferris, *Philip. Journ. Sci.*, XXVII, iii, p. 415 (1925).

Pseudolynchia Bequaert, *Psyche*, XXXII, p. 271 (1926).

Genotype: *Olfersia maura* Bigot.

1. **Pseudolynchia maura** (Bigot) Fig. 19.

Olfersia maura Bigot, *Ann. Soc. Ent. France* (6), V, p. 237 (1885).

Lynchia maura Speiser, *Zeitschr. Syst. Hym. u. Dipt.*, II, pp. 155, 163 (1902).

Olfersia capensis Bigot.

Olfersia lividicolor Bigot, *Ann. Soc. Ent. France*, XXXV, p. 238 (1885).

Lynchia brunnea lividicolor, Patton & Cragg, *Textb. Med. Ent.*, p. 407 (1913).

Lynchia maura (Bigot) Ferris, *Philip. Journ. Sci.*, XXVII, iii, p. 416, f. 2, 3 (1925).

Lynchia maura (Bigot) Bequaert, *Med. Rep. Rice-Harvard Exped.*, p. 241 (1926).

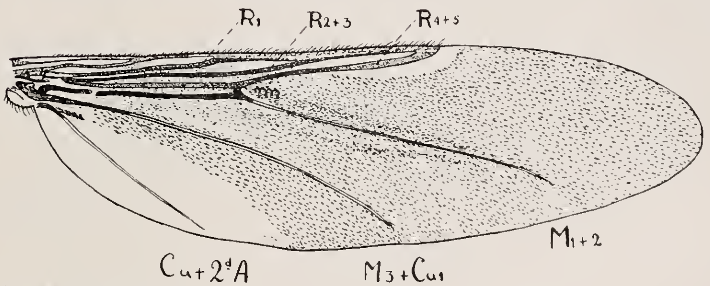

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Fig. 19. Wing of *Pseudolynchia maura* (Bigot).

This species is widely distributed on pigeons in various parts of the world. It is a common parasite of domestic pigeons in the Pretoria District, and is the transmitting agent of *Haemoproteus columbae* Kruse as was first demonstrated by Edm. & Et. Sergent (C. R. Soc. Biol., LXI, pp. 494-496, 1906); later by R. Gonder (*Repts. Dir. Vet. Res., Un. S. Afr.*, III & IV, pp. 625-632, 1915).

Genus Olfersia Wiedemann.

Olfersia Wiedemann, *Aussereurop. Zweifl. Ins.*, II, p. 605 (1830).

Feronia Leach, *Gen. Spec. Eproboscideous Ins.*, p. 4 (1817).

Pseudolfersia Coquillet, *Canad. Ent.*, XXXI, p. 336 (1899).

Olfersia (Wied.) Ferris, *Philip. Journ. Sci.*, XXXIV, ii, p. 220 (1927).

Genotype: *Feronia spinifera* Leach.

1. **Olfersia spinifera** (Leach).

Feronia spinifera Leach, *Mem. Wernerian Nat. Hist. Soc.*, II, p. 557, Pl. 26, f. 1-3 (1818).

Pseudolfersia spinifera (Leach) Austen, *Ann. Mag. Nat. Hist.* (7) XII, p. 265 (1903).

Olfersia spinifera (Leach) Ferris, *Philip. Journ. Sci.*, XXXIV, ii, p. 220, f. 10, 11 (1927).

Austen (1909) records this species in his list of blood-sucking Diptera found in the Cape Province. It has been recorded taken off *Fregata minor* Gmel. (= *F. aquila* Linné), frigate bird, in various parts of the tropics. *O. diomedeae* (Coquillet) is probably a distinct species. Ferris & Cole (1922) have described and figured it under the name *Pseudolfersia spinifera* (Leach).

Genus LYNCHIA Weyenbergh.

Lynchia Weyenbergh, *Anal. Soc. Cientif. Argent.*, XI (1881).

Icosta Speiser, *Zeitschr. f. syst. Hym. u. Dipt.*, V, p. 358 (1905).

Ornithoponus Aldrich, *Ins. Inscit. Menstruus*, XI, p. 78 (1923).

Ornithoponus Ferris, *Philip. Journ. Sci.*, XXVIII, iii, p. 332 (1925).

Lynchia Bequaert, *Psyche*, XXXII (1925).

Lynchia Ferris, *Philip. Journ. Sci.*, XXXIV, ii, p. 223 (1927).

Olfersia of most authors.

Genotype: *Lynchia penelopes* Weyenbergh.

1. **Lynchia ardeae** (Macquart).

Olfersia ardeae Macq., Suites à Buffon. Dipt., II, p. 640 (1835).

Olfersia ardeae (Macq.) Massonnat, *Ann. de l'Univer. de Lyon*, I, Sci. Méd., XXVIII, p. 309, Pl. 5, f. 43-46 (1909).

Ornithoponus ardeae (Macq.) Falcoz, Faune de France, 14, Dipt. Pupipares, p. 32, f. 30, 31 (1926).

Specimens have been taken off the following hosts in the Pretoria District, 1930: *Pyrrherodia purpurea* (purple heron), *Egretta garzetta* (little egret) and *Bubulcus ibis* (buff-backed egret). It has also been recorded by Falcoz (1926) from *Ardea cinerea* (common grey heron).

2. **Lynchia minor** (Bigot).

Austen (1909) records this species in his list of blood-sucking Diptera found in the Cape Province.

3. **Lynchia pilosa** (Macquart).

Olfersia pilosa Macq., *Mem. Soc. Lille*, 1841, p. 434 (1842).

One specimen taken off *Choriotis kori* Burch. (giant bustard) at Nongoma, Zululand, 26th July, 1921 (coll. H. H. Curson). In the British Museum collection there is a specimen taken

off white-quilled bustard, *Afrotis afroides* A. Sm. *(= Compsotis leucoptera)* in the Wolmaransstad District, Transvaal, 24th July, 1902 (coll. G. E. B. Hamilton); also two specimens taken off the greater bustard in Kenya Colony.

Genus CRATAERINA Von Olfers.

Crataerina von Olfers, *De Vegetatiris et Animatis Corporibus in Corporibus Animatis Reperiundis. Commentarius*, Pars 1, p. 101 (Berolini, 1816).

Anapera Meigen, *Syst. Beschr. d. europ. zweiflüg. Insekt. (Diptera)*, p. 234 (1830).

Chelidomyia Roudani, *Bull. Soc. Ent. Ital., Firenze*, XI, p. 10 (1879).

Crataerina Austen, *Parasit.*, XVIII, iii, p. 351 (1926).

Crataerina Ferris, *Philip. Journ. Sci.*, XLIII, iv, p. 547 (1930).

This genus includes seven species found on *Macropterygidae.*

Genotype: *Ornithomyia pallida* Latreille *(= Crataerina lonchoptera von Olfers)*, parasitic upon *Micropus apus* Linné (European swift), migrant to South Africa.

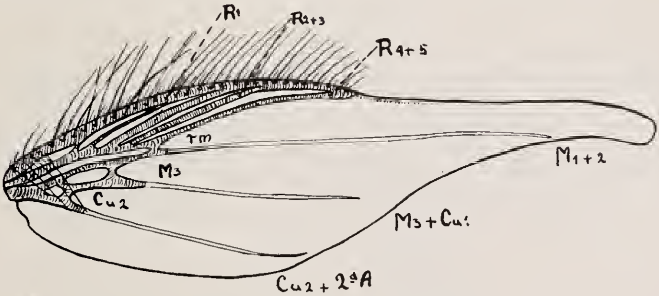

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Fig. 20. Wing of *Crataerina acutipennis* Austen.

1. **Crataerina acutipennis** Austen (Fig. 20).

Crataerina acutipennis Austen, *Parasit.*, XVIII, iii, p. 355, f. 1a (1926).

Crataerina acutipennis (Aust.) Ferris, *Philip. Journ. Sci.*, XLIII, iv, p. 549, f. 7b (1930).

Described from specimens collected in Pretoria; from swift's nest, Durban, Natal, and from *Micropus unicolor unicolor* Jardine and *Micropus murinus brehmorum* Hart, at Madeira and Canary Is. We have taken specimens from nests of the Indian swift, *Colletoptera affinis* (Grey), Union Buildings, Pretoria, 4th November, 1930, and Ferris (1930) has recorded a female taken off the same host in Ceylon.

Genus STENEPTERYX Leach.

Stenepteryx Leach, *Mem. Wern. Nat. Hist. Soc.*, II, pp. 549, 551 (1818).

This genus includes a single species found on *Chelidonaria urbica* Linné (house martin) in Europe. It is possible that this insect hibernates throughout the winter in Europe in the pupa stage in its host's nest.

Genotype: *Hippobosca hirundinis* Linné.

Family STREBLIDAE.

The flies belonging to this family are parasitic upon bats, with the exception of *Strebla avium* Macquart, which is recorded from doves and parrots. They are small insects and usually possess wings (vestigial or absent in some exotic species). The head is not flexed on the dorsum of the thorax. Eyes when present small; ocelli absent. Antennae, situated in pits, two-jointed, with an arista. Palpi broader than long, leaf-like, projecting in front of the head, but not forming a sheath for the proboscis. Hind coxae enlarged; claws not distinctly toothed; pulvilli present.

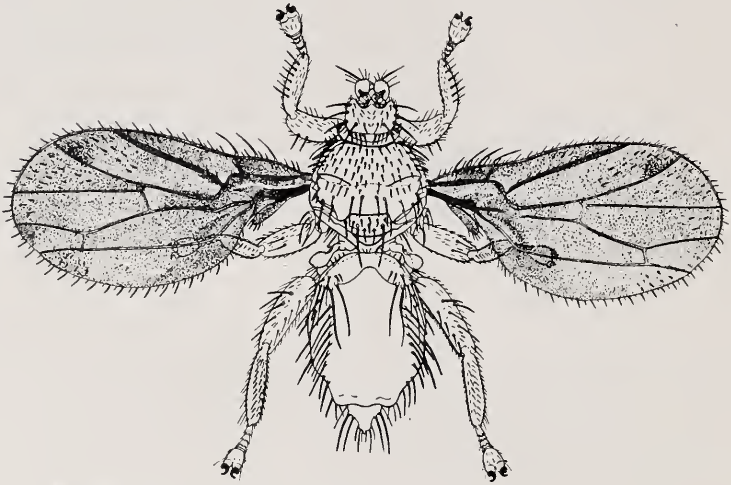

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Fig. 21. *Raymondia bedfordi* Ferris, dorsum of female.

The head and mouth parts have been described by Jobling (Parasit., XXI, iv, pp. 417-445, f. 1-6 and Pls. 18-20, 1929).

Key to the South African Genera.

Head somewhat flattened, closely articulated to flattened thorax; eyes absent, coxae i widely separated *Raymondia.*

Head and thorax highly convex; head freely movable; eyes one faceted; coxae i close together ... ... *Nycteribosca.*

Genus Raymondia Frauenfeld.

Raymondia Frauenfeld, *Sitzungsber Akad. Wiss. Wièn.* XVIII, p. 328 (1855).

Strebla Kolenati, *Die Parasiten der Chiroptera.* Bruenn (1856).

Raymondia Jobling, *Parasit.*, XXII, iii, p. 284 (1930).

This genus contains six species and one variety found in Africa and Asia.

Genotype: *Raymondia huberi* Frauenfeld.

1. **Raymondia bedfordi** Ferris (Fig. 21).

Raymondia bedfordi Ferris, *Parasit.*, XXII, iii, p. 281, f. 5, 6 (1930).

Raymondia quadriceps Jobling, *ibid.*, p. 295, f. 7, 8 (1930).

Described by Ferris from *Nycteris damarensis* Ptrs., Kaokoveld, South-West Africa. *R. quadriceps*, which is a synonym, was described from specimens taken off an undetermined bat from British Somaliland.

2. **Raymondia huberi** Frauenfeld.

Raymondia huberi Frauenfeld, *Sitzungber. Akad. Wiss. Wièn*, XVIII, p. 331, f. 2 a-g (1855).

Strebla africana Kolenati, *Die Parasiten der Chiroptern.* Dresden (1856).

Raymondia huberi huberi (Frauenf.) Jobling, *Parasit.*, XXII, iii, p. 298, f. 8, 10 (1930).

Recorded taken off *Hipposideros caffer* in Zululand; also off bats in British East Africa, Abyssinia and Egypt. We have taken it off an undetermined bat at Onderstepoort (det. Major E. E. Austen).

Genus Nycteribosca Speiser.

Nycteribosca Speiser, *Wiener Ento. Zeit.*, XVIII, p. 46 (1899).

This genus contains nine species, four being found on bats in Africa.

Genotype: *Brachytarsina amboinensis* Rondani.

1. **Nycteribosca africana** Walker.

We have taken specimens off an undetermined bat at Onderstepoort (det. Major E. E. Austen).

2. **Nycteribosca kollari** (Frauenfeld).

Raymondia kollari Frauenfeld, *Sitzunsber. Akad. Wiss. Wièn.* XVIII, p. 329, f. 1a, b (1855).

Recorded by Ferris (1930) taken off *Rhinolophus geoffroyii augur* Anders, near Pretoria.

Family NYCTERIBIIDAE.

The insects belonging to this small family are parasitic upon bats. They are small, apterous, and possess elongated legs. When at rest the head is folded back and lies in a groove on the dorsum of the thorax. Eyes when present vestigial; ocelli absent. Antennae situated in pits, two-jointed, with an arista which is dorsal. On the latero-anterior margin of thorax there is usually a fan-shaped comb of stout setae (ctenidium) inserted in a hollow, and a ctenidium is usually also present on the first sternite. Rodhain and Bequaert (*Bull. Sc. Zool. de France*, XL, viii-x, pp. 248-262, 1916) have recorded observations on the biology of *Cyclopedia greeffi* Karsch, a parasite of bats in the Belgian Congo.

The head and mouth parts have been described by Jobling (Parasit., XX, pp. 254-272, 1928).

Key to the South African Genera.

1. Tibiae with two clear rings; each eye composed of a single facet ... ... *Eucampsipodia.*
   Tibiae without rings 2
2. Abdomen and legs with long brush-like setae; eyes distinct, composed of one facet ... ... *Penicillidia.*
   Abdomen and legs without brush-like setae; eyes absent *Nycteribia.*

In the above genera ctenidia are present on the thorax and first sternite.

Genus EUCAMPSIPODA Kolenati.

Eucampsipoda Kolenati, *Die Parasiten der Chiroptern*, Dresden, p. 62 (1857).

A small genus comprising three or four species.

Genotype: *Nycteribia hyrtli* Kolenati.

1. **Eucampsipodia hyrtli** (Kolenati).

Nycteribia hyrtli Kolenati, *Die Parasit. d. Chiropt.* Brünn., p. 42 (1856).

Eucampsipodia hyrtli (Kolen.) Scott, *Ann. Mag. Nat. Hist.* (8) XIV, p. 228, Pl. 12, f. 18, 19 (1914).

Scott (1914) records this species taken off a bat in South Africa. It has also been found on bats in Egypt, Senegal, Comoro Islands, Sumatra, Burma, and Ceylon. Among the list of hosts recorded is the fruit bat, *Rousettus aegyptiacus.*

Genus PENICILLIDIA Kolenati.

Penicillidia Kolenati, *Horae Soc. ent. Ross.*, V, ii, p. 69 (1863).

This genus includes fifteen species, three of which have been recorded from Africa.

Genotype: *Penicillidia conspicua* Speiser (= *westwoodii* Kolen.).

1. **Penicillidia fulvida** (Bigot).

Nycteribia fulvida (Bigot), *Ann. Soc. ent. France*, V, v, p. 246 (1885).

Type locality: Cape of Good Hope. In the British Museum collection there is one male taken off *Vespertilio* in Natal by Dr. Krause; also one male from unknown locality. A ♀ and ♂ were sent by J. Hewitt taken off *Nycteris capensis* (Cape long-eared bat), Albany District, C.P. (coll. Austin Roberts), and a ♀ has been taken off *Miniopterus natalensis* in a cave at Irene, near Pretoria, 25th October, 1931 (coll. G.A.H.B.).

Genus Nycteribia Latreille.

This genus is widely distributed and contains about forty-four species; seven of which have been recorded from Africa.

1. **Nycteribia schmidlii** Schiner.

N. schmidlii, Schiner, *Verh. zool.-bot. Ver. Wien*, V, iii, p. 151 (1853).

N. (Listropodia) schmidli (Sch.) Falcoz, Faune de France, Dipt. Pupipares, p. 51, f. 73-76 (1926).

Specimen taken off *Miniopterus natalensis* A. Smith (Natal sociable bat) at Wonderboom, near Pretoria, on the 31st July, 1927. Dr. Scott informs me that they are slightly larger than specimens from Algeria and may be distinct. This species has also been recorded from various bats in Europe.

2. **Nycteribia scissa** Speiser.

N. (Acrocholidia) scissa Speiser, *Arch. f. Naturg.*, LXVI (1900).

Described from specimens taken off *Rhinolophus capensis* Licht (Cape long-eared bat) in South Africa.

3. **Nycteribia sp.**

One female taken off *Rhinolophus darlingi* at Onderstepoort. Dr. Scott informs me that it is close to but distinct from *N. vexata* West., a European species. He did not compare it with *N. scissa*. Also one female and one male, which may be the same, taken off *Rhinolophus geoffroyii augur* in a cave near Pretoria.

Order Siphonaptera.

This order, sometimes called *Aphaniptera*, includes the fleas. The adults are small, chitinous, apterous, laterally compressed insects; eyes may be present or absent; the antennae are short and stout, reposing in grooves, the mouth-parts are modified for piercing and sucking; the coxae are very large and the tarsi five-jointed. They are temporary ectoparasites of both mammals and birds. The eggs are ovoid and white or cream in colour. The larvae are whitish, vermiform in shape and possess a well-developed head, and three thoracic and ten abdominal segments; spiracles are present on the

thorax and first eight abdominal segments; both eyes and legs are absent; the antennae are single-jointed and the mandibles toothed. They are active, non-parasitic, and feed on organic matter among dust and dirt or in their host's nest or lair. Blood which has passed through the alimentary canal of adult fleas appears to be a necessary nutriment to some species. The pupae are enclosed in cocoons. About 500 species are known, of which 64 have been recorded from South Africa.

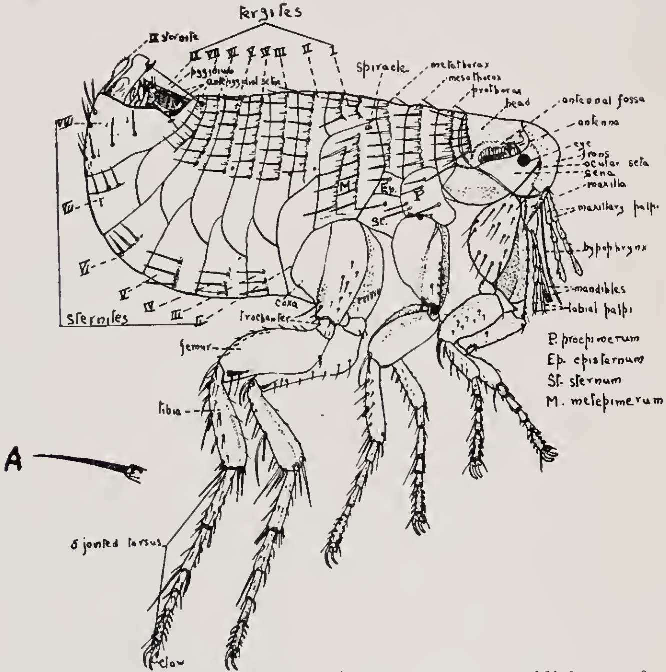

Fig. 22. *Xenopsylla cheopis* (Roths.), ♂. A, Antepygidial seta of *X. brasiliensis* (Baker).

The fleas have been divided into a number of families, but only three are retained here. The families Dolichopsyllidae and Hystrichopsyllidae cannot be recognized because in the genus *Chiastopsylla* the head may or may not be divided by a dorsal incrassation extending from the base of antenna to the vertex; moreover, in some species it is frequently difficult to determine whether the frons is divided from the occiput or not. The former family can also not be separated from the Pulicidae, because in the genus *Praopsylla* there is only one row of setae on tergites II to VII, and this genus is said to be closely allied to *Chiastopsylla*. The subfamilies Ctenophthalminae, Uropsyllinae and Dolichopsyllinae likewise cannot be recognized because in the genus *Chiastopsylla* a genal comb may be either present or absent, and in some species it is very difficult to determine whether the head is provided with a frontal tubercle or not.

Key to the Families.

1. The three segments of the thorax together always longer than the first abdominal tergite; rostrum consisting of four or more segments; combs absent or present; abdomen of gravid females only slight, if at all, enlarged 2

   The three segments of the thorax together always shorter than the first abdominal tergite; rostrum consisting of three, or fewer, very feebly chitinized segments; combs absent; abdomen of gravid females always distended **Tungidae.**

2. Head without a pair of antero-ventral flaps on each side. Not on bats ... ... **Pulicidae**, p. 435

   Head with a pair of antero-ventral flaps (modified spines) on each side which project downwards opposite the mouth cavity. On bats ... ... **Ischnopsyllidae,** p. 461

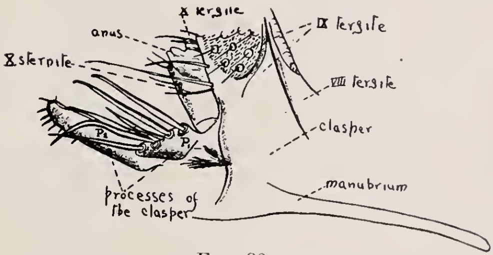

Fig. 23.

Fig. 24.

Fig. 23. Modified terminal abdominal segments of ♂ of *Xenopsylla brasiliensis.* (Baker).

Fig. 24. Receptacula seminis of ♀ of *Xenopsylla brasiliensis* (Baker).

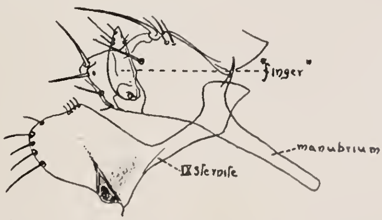

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Fig. 25. Terminal abdominal segments of ♂ of *Chiastopsylla pitchfordi* Ingram.

Family TUNGIDAE.

No less than four other names have been used for this family, including Sarcopsyllidae. It is a small family and includes only three genera. The species are known as chigoes or jigger fleas.

Key to the South African Genera.

Hind coxae with a patch of spines on inner side *Echidnophaga.*

Hind coxae without such a patch of spines ... ... *Tunga.*

A. B. C.

A, *Echidnophaga larina*; B, *Pulex irritans*; C, *Pariodontis riggenbachi*.

D. E. F.

D, *Ctenocephalides felis*, ♂, head and prothorax; E, *Ctenocephalides canis*, ♂; F, *Ceratophyllus fasciatus*.

G. H. I.

G, *Chiastopsylla rossi*; H, *Listropsylla dorippae*; I, *Dinopsyllus lypusus*.

J. K. L.

J, *Hypsophthalmus granti*; K, *Leptopsylla segnis*; L, *Araeopsylla scitulus*.
A. B. M. Whitnall del.

Fig. 26. Heads of South African fleas (not drawn to the same scale).

Genus Tunga Jarocki.

Tunga Jarocki, *Zool., or General Descr. of Animals in accord. with the Latest System* (In Polish), pp. 50-52, Pl. 2, f. 10-13 (1838).

Dermatophilus Guerin, *Icon. Règne, Anim., Ins.*, p. 12 (1839).

Dermatophilus Jord. & Roths., *Thomp. Yates & Johnst. Labs. Rep.*, VII, i, p. 65 (1906).

This genus includes three species, of which one, the jigger flea of man, occurs in South Africa.

Genotype: *Pulex penetrans* Linné.

1. **Tunga penetrans** (Linné).

Pulex penetrans Linné, *Syst. Nat.* ed. X, p. 614 (1758).

Dermatophilus penetrans (L.) Jord. & Roths., *Thomp. Yates & Johnst.* Labs. Rep. VII, i, p. 67, f. F, Pl. 4, f. 28 (1906).

Recorded from man and several animals, including pig, in South America, West Indies, W. and E. Africa, and Madagascar. It is a common parasite of man in many localities along the coastal belt of Natal and Zululand. It penetrates the skin, and the feet are most subject to attack.

Genus Echidnophaga Olliff.

Echidnophaga Olliff, *Proc. Linn. Soc.*, New South Wales (2), I, p. 172 (1886).

Echidnophaga Jord. & Roths., *Thomp. Yates & Johnst. Labs. Rept.*, VII, i, p. 43 (1906).

This genus includes ten species, four of which have been found in South Africa.

Genotype: *Echidnophaga ambulans* Olliff.

Key to the South African Species (after Jordan and Rothschild).

1. Fifth tarsal segment on each side with five heavy setae *E. bradyta* J. & R.
   Fifth tarsal segment on each side with three heavy setae and a smaller fourth 2
2. Fifth tarsal segment with one apical ventral seta *E. aethiops* J. & R.
   Fifth tarsal segment with two apical ventral setae 3
3. Second seta of fifth tarsal segment midway between first and third ... ... *E. gallinacea* Westw.
   Second seta nearer the first than the third *E. larina* J. & R.

1. **Echidnophaga aethiops** Jordan and Rothschild.

Echidnophaga aethiops Jord. & Roths., *Thomp. Yates & Johnst. Labs. Rep.*, VII, i, p. 51 (1906).

Described from a female taken off a bat at Klipfontein, Namaqualand.

2. **Echidnophaga bradyta** Jordan and Rothschild.

Echidnophaga bradyta Jord. & Roths., *Thomp. Yates & Johnst. Labs. Rep.*, VII, i, p. 47, pl. 2, f. 13; pl. 3, f. 23 (1906).

Described from specimens taken off the suricate, *Suricata suricatta (=S. tetradactyla);* ground squirrel *Geosciurus capensis (= Xerus capensis)* and stink muishond, *Ictonyx striata (= Zorilla striata)* at Deelfontein, C.P. Mitchell (1921) has recorded it from *G. capensis* and *Cynictis penicillata* (yellow mongoose) near Bothaville, O.F.S. Ingram (1927b) has recorded it from the following hosts: *C. penicillata* at Thopjies and Frankfort in the O.F.S.; *S. suricatta* at Blesboklaagte, Kroonstad District; *G. capensis* at Bultfontein and the Barrage, O.F.S. We have also taken females off *S. suricatta* in the Pretoria District.

3. **Echidnophaga gallinacea** (Westwood).

Sarcopsylla gallinacens Westwood, *Ent. Month Mag.*, XI, p. 246 (1875).

Echidnophaga gallinacens Jord. & Roths., *Thomp. Yates & Johnst.* Labs. Rep., VII, i, p. 52, pl. 1, f. 1; pl. 2, f. 14; pl. 3, f. 21; pl. 4, f. 27 (1906).

This species is very common on fowls, dogs and cats in South Africa. It has also been recorded from Europe, America, Asia, Fiji Islands, West and East Africa, and Madagascar. Jordan and Rothschild (1906) have recorded it from the following hosts in South Africa: Suricate, *Suricata suricatta (=S. tetradactyla)* and bay mongoose, *Myonax ratlamuchi (=Herpestes badius)* at Deelfontein, Cape Province; also from *Lepus capensis* at Port Nolloth and a hawk at Durban. Waterston (1914, 1915) has recorded it taken off *Philantomba monticola* (blue duiker) and Cape barn owl, *Typo alba affinis (= Strix flaminea)*, also from black rat, *Rattus rattus (= Mus rattus)* at Grahamstown, Cape Province. Mitchell (1921) has recorded it taken off the following hosts near Bothaville, Orange Free State: ground squirrel, *Geosciurus capensis (= Xerus capensis), Cynictis penicillata* (yellow mongoose) and *Suricata suricatta (suricate).* Ingram (1927b) has recorded it from the following hosts: *C. penicillata* at Thopjies and Frankfort, O.F.S.; *S. suricatta* at Blesboklaagte, Kroonstad District, and Bultfontein, O.F.S.; *G. capensis* at the Barrage and Bultfontein, and *Rattus rattus* at East London. Dr. Ingram also received specimens taken off *Mastomys coucha* (multimammate mouse) at Rendezvous, Kroonstad District. We possess specimens taken off *Thos mesomelas* (black-backed jackal) at Vryburg, C.P., 28th June, 1916; *Rattus rattus frugivorus* (arboreal black rat) and *Passer melanurus* (Cape black-headed sparrow) at Onderstepoort; off *Pedetes caffer* (springhare) and *Vulpes chama* (silver fox) at Petrusburg, O.F.S. (coll. G.A.H.B.); *G. capensis*, Vryburg, C.P. (coll. P. L. le Roux); *Mungos mungo* (banded mongoose), Umfolosi Reserve, Zululand (coll. P. L. le Roux); *Eptesicus capensis gracilior* (Cape house bat), Sycamore, Tvl.,

and *C. penicillata*, Pretoria District. Specimens have also been taken off *Sulita capensis* (melagas) at Port Alfred, C.P., 25th July, 1923 (coll. J. Hewitt, det. J. Waterston); off man at Umbilo, Natal (coll. C. C. Kent) and at N'Changa, Northern Rhodesia (coll. G.A.H.B.), and from *Tatera lobengulae* (gerbille), Pitsani, Molopo, Bechuanaland Protectorate (B. De Meillon).

4. **Echidnophaga larina** Jordan and Rothschild. (Fig. 26A.)

Echidnophaga larina Jord. & Roths., *Thomp. Yates & Johnst. Labs. Rep.*, VII, i, p. 49, Pl. 1, f. 12; Pl. 2, f. 18; Pl. 3, f. 25 (1906).

Described from specimens taken off a dog in Somaliland; *Crocuta crocuta (= Hyaena crocuta)* and *Panthera pardus (= Felis leopardus)* in Abyssinia; also from the following hosts at Deelfontein, C.P.: Cape ant-bear, *Orycteropus afer (= O. capensis);* hedgehog, *Atelerix frontalis (= Erinaceus frontalis);* Cape porcupine, *Hystrix africae-australis (= H. cristatus*), and grey mongoose, *Myonax pulverulentus (= Herpestes pulverulentus).* Mitchell (1921) has recorded it from *Mastomys concha* (multimammate mouse), Bothaville, O.F.S. It is common on *Phacochoerus sunderalli* (Natal warthog) in Zululand, and we also possess specimens taken off the following hosts: dog at Ntabanana, Zululand; *Lycaon pictus* (Cape hunting dog), Umfolosi, Zululand, 22nd August, 1928 (coll. Austin Roberts), and Zoological Gardens, Johannesburg, August, 1930 (coll. G. Martinagalia); also from eye-lids of cattle, Pretoria District, 16th August, 1928 (coll. A. Coles); horses, Maseru, Basutoland, August, 1928 (coll. F. A. Verney); *Felis ocreata caffra* (Cape wild cat), Worcester, C.P. (coll. P. L. le Roux); *Vulpes chama* (silver fox), Petrusburg, O.F.S.; *Proteles cristatus* (aardwolf), Umkomaas Valley, Natal (coll. L. Hill), and one female off *Smutsia temminckii* (scaly ant-bear), Rustenburg District, Tvl. (coll. G.A.H.B.).

Family PULICIDAE.

Key to the Genera.

1. Tergites I-VII with a single row of setae and without spines; hind coxa with small spines on inner side; pronotal comb usually absent 2
   Tergites I-VII with at least two rows of setae, and spines usually present; hind coxa usually without spines on the inner side; pronotal comb present 8
2. Eyes vestigial; genal and pronotal combs absent *Praopsylla*, p. 450.
   Eyes present 3
3. Mesopleura without internal rod-like ridge from base of the coxa upwards; genal and pronotal combs absent *Pulex*, p. 437.
   Mesopleura with internal rod-like ridge from base of the coxa upwards 4

4. Genal and pronotal combs present ... *Ctenocephalides*, p. 446.
   Genal and pronotal combs absent 5
5. Genal margin of head formed into a large acute process; pronotum much longer than mesonotum *Pariodontis*, p. 437.
   Genal margin of head not formed into a large acute process; pronotum shorter than mesonotum 6
6. Metepisternum fused with metasternum *Synosternus*, p. 439.
   Metepisternum separated from metasternum 7
7. Middle of outer surface of club of antenna segmented down to ventral outline; hind coxa gradually narrowed posteriorly from middle to apex, comb near apex *Procaviopsylla*, p. 438.
   Club of antenna not segmented on outer surface; hind coxa with the posterior area expanded distally; comb nearer to middle than to apex ... ... *Xenopsylla*, p. 440.
8. Eyes present 9
   Eyes absent or vestigial 14
9. Frontal tubercle large, leaf-like; three to four pairs of antepygidial setae; ♀ with a long projection between the two sets; genal comb absent; tergites without apical spines ... ... *Listropsylla*, p. 454.
   Frontal tubercle either small or wanting; ♀ without a process between the antepygidial setae, except in *Stivalius* ... 10
10. Pygidium very strongly convex, projecting backwards over base of anal tergite; genal comb absent *Stivalius*, p. 449.
    Pygidium not strongly convex 11
11. Hind coxa with small spines on inner side; genal comb present ... ... *Hypsophthalmus*, p. 459.
    Hind coxa without spines 12
12. One pair of antepygidial setae; genal comb absent or present, if present with two teeth crossing each other; small species ... ... *Chiastopsylla*, p. 450.
    Three pairs of antepygidial setae 13
13. Frontal region continuous with the occiput, there being no dorsal incrassation from the base of antenna to the vertex of head; genal comb absent ... ... *Ceratophyllus*, p. 448.
    Dorsal incrassation present from the base of antenna to the vertex of head; genal comb usually present *Dinopsyllus*, p. 457.
14. Tibiae without a row of spines on posterior margin; genal comb usually with three teeth; no spines on frons *Ctenophthalmus*, p. 456.
    Tibiae with a row of tooth-like spines on posterior margin; genal comb present; small spines near front angles of frons ... ... *Leptopsylla*, p. 460.

Genus PULEX Linné.

Pulex Linné, *Syst. Nat.*, X, p. 614 (1758).

Pulex (Linné) Jord. & Roths., *Parasit.*, I, p. 5 (1908).

This genus contains two species.

Genotype: *Pulex irritans* Linné.

1. **Pulex irritans** Linné (Fig. 26B).

Pulex irritans Linné, *Syst. Nat.*, X, p. 614 (1758).

Pulex irritans (Linné) Jord. & Roths., *Parasit.*, I, p. 7 (1908).

This species has been recorded from various parts of the world. It is a parasite of man, and has also been found on various animals, including the badger in Europe, dogs, cats, etc. It is fairly common on dogs at Onderstepoort, and we have also taken it off *Thos mesomelas* (black-backed jackal) at Vryburg, C.P., 28th June, 1916, and off man at Wellington, C.P. It has been taken off man in the Uitenhage District, Cape Province, and has been recorded to occur freely in Kaffir kraals at Kingwilliamstown, C.P. (Waterston, 1914). Jordan and Rothschild (1908) record it from caracal, *Caracal caracal (= Felis caracal)*, Deelfontein, C.P. Ingram (1927b) has recorded taking single specimens off *Geosciurus capensis* (ground squirrel) and *Mastomys coucha* (multimammate mouse) at the Barrage, O.F.S. Waterston (1915) records it from *Proteles cristatus* (aard wolf) in South Africa. It is a transmitting agent of *Trypanosoma lewisi* to rats, and a secondary host of *Dipylidium caninum*, *Hymenolepis diminuta*, *Dipetalonema reconditum* and *D. perstans*, only the first named worm being known to occur in the Union.

Genus PARIODONTIS Jordan and Rothschild.

Pariodontis Jord. & Roths., *Parasit.*, I, p. 13 (1908).

This genus contains two species found on porcupines, one occurring in Asia, the other in Africa.

Genotype: *Pulex riggenbachi* Rothschild.

1. **Pariodontis riggenbachi** (Rothschild). Fig. 26C.

Pulex riggenbachi Roths., *Nov. Zool.*, XI, p. 611 (1904).

Pariodontis riggenbachi Jord. & Roths., *Parasit.*, I, p. 14, Pl. 2, f. 1 (1908).

This species was described from specimens taken off *Hystrix cristatus* in Morocco, and from *H. africae-australis (= H. cristatus)* at Deelfontein, Cape Province. It is a common parasite on the Cape porcupine in South Africa, and has also been found in Angola, South-West Africa and East Africa.

Genus Procaviopsylla Jordan.

Procaviopsylla Jordan, *Nov. Zool.*, XXXII, p. 102 (1925).

Procaviopsylla Jordan, *Verhandl. III. Intern. Ento-Kongr.*, Zürich, II, p. 604 (1926).

This genus is confined to Africa, and includes five species found on Procaviidae (dassies), and also accidentally on other mammals and on birds. The majority of the species were formerly included in the genus *Xenopsylla*. *P. isidis* Roths. has been recorded from South Africa, but it does not occur south of the Rift Valley

Genotype: *Pulex isidis* Rothschild.

Key to the Species (after Jordan).

1. Males: process P^1 of clasper not projecting beyond P^2 2
   Females: hind tibia with seven or eight notches bearing stout setae, inclusive of apical notch 4
2. Proboscis longer than maxillary palpus ... ... *P. divergens.*
   Proboscis at most as long as maxillary palpus 3
3. Hind tibia with eight dorsal notches bearing stout setae *P. angolensis.*
   Hind tibia with seven dorsal notches bearing stout setae *P. creusae.*
4. Hind tibia with eight dorsal notches bearing stout setae *P. angolensis.*
   Hind tibia with seven dorsal notches bearing stout setae ... 5
5. Proboscis reaching to apex of maxillary palpus ... *P. creusae.*
   Proboscis reaching beyond apex of maxillary palpus *P. divergens.*

1. **Procaviopsylla angolensis** Jordan.

Procaviopsylla angolensis Jordan, *Nov. Zool.*, XXXII, p. 102, f. 12 (1925).

Procaviopsylla angolensis Jordan, *Verhandl. III. Intern. Ento-Kongr.*, Zürich, II, p. 606 (1926).

Described from a female and males taken off *Procavia sp.* in Angola. I have taken specimens off *Procavia coombsi* Rbts. (Transvaal dassie) at Onderstepoort on the 22nd August, 1928, and have also received specimens from the same host in the Rustenburg District, Transvaal.

2. **Procaviopsylla creusae** (Rothschild).

Pulex creusae Roths., *Nov. Zool.*, XI, p. 608, Pl. 8, f. 18; Pl. 9, f. 25 (1904).

Loemopsylla creusae (Roths.) Jord. & Roths., *Parasit.*, I, p. 54, Pl. 2, f. 11; Pl. 4, f. 12 (1908).

Procaviopsylla creusae (Roths.) Jord., *Verhandl. III. Intern. Ento-Kongr.*, Zürich, II, p. 605 (1926).

Described from specimens taken off Cape dassie, *Procavia capensis (sp. dub.)* and also accidentally off *Caracal caracal (=Felis caracal)* and *Spreo bicolor* (pied starling) at Deelfontein, C.P.; also off *Procavia capensis* (*sp. dub.*) at Wakkerstroom, Transvaal. Dr. Ingram has received specimens taken off a dassie at Middelkraal, C.P., and specimens have been taken off *Procavia natalensis*, Fir Glen, Albany District, C.P. (coll. A. Roberts), and *Procavia capensis*, Capetown, C.P. (coll. R. F. Lawrence).

3. **Procaviopsylla divergens** (Jordan and Rothschild).

Loemopsylla divergens Jord. & Roths., *Parasit.*, I, p. 57, Pl. 2, f. 10; Pl. 6, f. 2 (1908).

Procaviopsylla convergens Jord., *Nov. Zool.*, XXXII, p. 102 (1925).

Procaviopsylla divergens (J. & R.) Jord., *Verhandl. III* Intern. *Ento.-Kongr.*, Zurich, II, p. 606 (1926).

Described from specimens taken off Cape dassie, *Procavia capensis* (*sp. dub.*), and also accidentally off *Caracal caracal (=Felis caracal)* at Deelfontein, Cape Province. Specimens have also been taken off *Procavia sp.* at Ntabamhlope, Natal on the 7th April, 1928.

Genus Synosternus Jordan.

Synosternus Jordan, *Nov. Zool.*, XXXII, p. 103 (1925).

Synosternus Jordan, *Verhandl. III. Intern. Ento.-Kongr.*, Zürich, II, p. 606 (1926).

This genus includes five species, one of which occurs in South Africa. They are mainly parasitic upon Rodentia and Erinaceidae, but stragglers are frequently found on Carnivora.

Genotype: *Pulex pallidus* Taschenberg.

1. **Synosternus caffer** (Jordan and Rothschild).

Xenopsylla caffer Jord. & Roths., *Ectoparasit.*, 1, v, p. 293, f. 282-284 (1923).

Synosternus caffer (J. & R.) Jord., *Verhandl. III. Intern. Ento.-Kongr.*, Zürich, II, p. 608 (1926).

Described from specimens taken off *Pedetes caffer* (springhare) at Bothaville, O.F.S., on the 5th January, 1921; also from specimens taken off *Genetta senegalensis*. We have also taken specimens off *Thos mesomelas* (black-backed jackal) at Vryburg, C.P. on the 28th June, 1916. Dr. Ingram has received specimens taken off *P. caffer* at Bultfontein, Hoopstad and Brandfort in the O.F.S.; also at Sandfontein, S.W.A., and we have taken numerous specimens off the same host at Petrusburg, O.F.S., 13th November, 1930. Specimens have also been taken off *Vulpes chama* (silver fox) at Petrusburg.

Genus Xenopsylla Glinkiewicz.

Xenopsylla, Glink., *Sitz.-Ber. Akad. Wiss. Wien*, CXVI, 1. p. 381 (1907).

Loemopsylla Jord. & Roths., *Parasit.*, I, p. 15 (1908).

Xenopsylla (J. & R.) Jord., *Verhandl. III Intern. Ento.-Kongr., Zürich*, II, p. 609 (1926).

This genus includes thirty-two species occurring in Africa, Asia and southern Europe. One species, *X. brasiliensis*, has been introduced into Brazil. They are mainly parasitic upon Muridae and Sciuridae, and two species occur on birds.

Genotype: *Xenopsylla pachyuromyidis* Glink. = *cheopis* Roths.

Key to the Species.

1. ♂: segment v of foretarsi with three apical ventral spiniform setae; process of P^3 of clasper without setae. ♀ with numerous setae extending far upwards on tergite VIII ... 2

   ♂: segment v of foretarsi with four apical ventral spiniform setae; process P^3 of clasper with apical setae. ♀ with only 2 or 3 setae on the side of tergite VIII (apart from subapical row) ... ... *X. erilli*, p. 444.

2. No seta behind or above stigma of metepisternum 3

   At least one seta above this stigma or immediately behind it ... ... *X. trispinus*, p. 446.

3. Antepygidial seta of ♂ placed on a cone; ♀ with head of spermatheca much broader than base of tail, the dark colouring of tail almost confined to the swollen base ... 4

   Antepygidial seta of ♂ and ♀ not placed on a cone; ♀ with head of spermatheca not or only slightly wider than tail, tail darkened to about the middle; P^1 of clasper of ♂ without twisted or elbowed seta 11

4. ♂ with P^2 and P^1 sub-equal in length, the latter without thick twisted or elbowed seta; ♀ with a double chitinized sclerite behind entrance to bursa copulatrix *X. trifarius*, p. 446.

   ♂ with P^2 longer than P^1; ♀ without these sclerites 5

5. Hind tibia with six dorsal notches bearing stout setae, inclusive of apical notch 6

   Hind tibia with an additional stout seta between second and third pairs 10

6. ♂: tergite I and sternite VIII without brush of long setae; ♀: sternite VII with either 2 (rarely 3) or 5 to 7 setae on each side 7

   ♂: sternite VIII with a brush of long setae; ♀ sternite VII with 3 (rarely 4) setae on each side 8

7. Sternite VII in ♂ and ♀ with 2 (rarely 3 in ♀) setae on each side; apical portion of ejaculatory tube of ♂ with sharp dorsal tooth ... ... *X. hamula*, p. 444.

Sternite VII of ♂ and ♀ with 5 to 7 setae on each side; ejaculatory tube of ♂ without tooth *X. brasiliensis*, p. 442.

8. ♂: sternite VIII with 11 long, stout setae on apical margin, which is produced backwards; tergite I divided into two lobes, the setae at apex forming a brush; paramere without a dorsal projection; ♀ head of spermatheca almost spherical; tergite VIII with less than 20 setae on each side ... ... *X. sulcata*, p. 445.

♂: sternite VIII with 8 to 9 setae on apical margin, which is straight; paramere with dorsal angle produced; ♀: head of spermatheca less spherical 9

9. ♂: tergite I with long stout setae which project at an angle, the setae at apex forming a brush; antepygidial seta on a small cone; ♀: tergite VIII with more than 20 setae on each side ... ... *X. lobengulae*, p. 445.

♂: tergite I with more slender appressed setae; antepygidial seta on a slightly larger cone; ♀: tergite VIII with less than 20 setae on each side ... ... *X. hirsuta*, p. 444.

10. Eye only equalling that of second segment of maxillary palpus; sternite VIII of ♂ with less than 20 setae on each side; sternite VII of ♀ with less than 20 setae on both sides; base of tail of spermatheca not ventricose *X. tortus*, p. 445.

Eye larger; sternite VIII of ♂ with more than 20 setae on each side, without brush of long setae; sternite VII of ♀ with more than 26 setae on the two sides together; base of tail of spermatheca more or less ventricose *X. scopulifer*, p. 445.

11. ♂♂ 12

♀♀ 15

12. Ventral arm of sternite IX with the dorsal and ventral margins equally chitinised 13

Ventral arm of sternite IX dorsally and laterally transparent *X. versuta*, p. 446.

13. Last seta of sternite VIII small, close to apex; sternite IX widened proximally of middle 14

Last seta of sternite VIII farther from apex than from the preceding seta; sternite IX not widened proximally of middle, nor distinctly curved upwards *X. cheopis*, p. 442.

14. Spiral of penis long and twisted into a double coil *X. piriei*, p. 445.

15. Dorsal wall of oviduct behind entrance to bursa copulatrix with a conspicuous brown sclerite on each side
X. eridos, p. 443.
X. piriei, p. 445.

These sclerites absent 16

16. Sternite VII with a row of 6 setae on the two sides together; spermatheca small ... ... *X. versuta*, p. 446.

Sternite VII with more than 6 setae on the two sides together, with one or more setae in front of row; spermatheca larger ... ...*X. cheopis*, p. 442.

In addition to the above species, *Xenopsylla nubicus* Roths. has been recorded from South Africa (Waterston, 1915), but this species is known only to occur in North Africa and Palestine.

1. **Xenopsylla brasiliensis** (Baker) Figs. 23 and 24.

Pulex brasiliensis Baker, *Proc. U.S. Nat. Mus.*, XXVII, pp. 378, 379 (1904).

Loemopsylla vigetus Rothschild, *Nov. Zool.*, XVI, p. 53, Pl. 8, f. 3, 4 (1909).

Xenopsylla brasiliensis (Bak.) Roths., *Bull. Ent. Res.*, I, ii, p. 92, f. 8, 10 (1910).

Xenopsylla brasiliensis (Bak.) Jordan, *Verhandl. III. Intern. Ent.-Kongr.*, II, p. 611, f. 42, 57 (1926).

This species occurs in South, East and West Africa, also in India, and Brazil, where no doubt it was introduced. It is known to carry plague (Ingram, 1927b), and also to transmit *Trypanosoma lewisi* to rats.

Mitchell (1921) recorded it taken off arboreal black rat, *Rattus rattus frugivorus (= R. rattus fruginis)* near Bothaville, O.F.S. Ingram (1927b) records it taken off *Rattus rattus* at Johannesburg, and from *Mastomys coucha* (multimammate mouse) at Rendezvous, O.F.S., and has since received specimens taken off *Rhabdomys pumilio* (striped mouse) at Bellville, C.P., and two males along with *P. irritans* from the blanket of a native who died of plague in the Theunissen District, O.F.S. The author found this species common on *M. coucha* and *Aethomys chrysophilus* (African rat) at Sycamore, Eastern Transvaal, in October and November, 1927, and has also taken it off a cat at Onderstepoort. We have one male taken off *A. chrysophilus pretoriae* Rbts. at Pretoria (coll. Austin Roberts).

2. **Xenopsylla cheopis** (Rothschild) Fig. 22.

Pulex cheopis Roths., *Ent. Mo. Mag.* (2), XIV, p. 85, Pl. 1, f. 3, 9; Pl. 2, f. 12, 19 (1903).

Pulex murinus Tiraboschi *Arch. Parasit.*, VIII, p. 251, f. 15 (1904).

Pulex philippinensis Herzog., *Bull. Bur. Gov. Lab. Manila*, XXIII, p. 77, f. 26, 27 (1904).

Xenopsylla pachyuromyidis Glinkiewicz, *Sitz., Ber. Akad. Wiss. Wien.* CXVI, i, p. 381, Pl. 2, f. 1-4 (1907).

Loemopsylla cheopis (Roths.) Jord. & Roths., *Parasit.*, I, p. 42, Pl. 1; Pl. 2, f. 8; Pl. 4, f. 8; Pl. 6, f. 1 (1908).

Xenopsylla cheopis (Roths.) Jordan, *Verhandl. III. Intern. Ent.-Kongr.*, II, p. 614, f. 60, 71 (1926).

An Indo-African species which has become widely distributed throughout the tropics and sub-tropics. It is a well-known carrier of plague, and is a transmitting agent of *Trypanosoma lewisi* to rats; also a secondary host of the exotic worm, *Hymenolepis diminuta*. In South Africa it has been taken off the following hosts: Brown rat, *Rattus norvegicus* (= *Mus decumanus*), Pretoria (Jordan & Rothschild, 1908); *Rattus rattus* (black rat) near Bothaville, O.F.S. (Mitchell, 1921); bontebok, *Damaliscus dorcas* (= *D. pygargus*), Bredasdorp, C.P. (Waterston, 1915). Ingram (1927b) reports finding it on *R. rattus* at Johannesburg, and states that it is the commonest flea found on brown and black rats at the ports. He also records a single specimen from *Otomys irroratus* (water rat) at the Barrage, O.F.S., and having taken it off *Mystromys albicaudatus* (white-tailed rat) at Kromspruit, O.F.S. It is common on *R. rattus* and the varieties *frugivorus* and *alexandrinus* at Onderstepoort, and we have also taken it here off *Mastomys coucha* (multimammate mouse) and *Thallomys moggi* (Mogg's rat). We have also seen a ♂ taken off man, a ♂ off a cat, and a ♂ from a fowl at Maritzburg, Natal (coll. L. Hill).

3. **Xenopsylla eridos** (Rothschild).

Pulex eridos Roths., *Nov. Zool.*, XI, p. 611, Pl. 8, f. 21; Pl. 9, f. 23 (1904).

Loemopsylla eridos (Roths.) Jord. & Roths., *Parasit.*, I, p. 49, Pl. 7, f. 4 (1908).

Xenopsylla eridos (Roths.) Jordan, *Verhandl. III. Intern. Ent.-Kongr.*, II, p. 615, f. 59, 77 (1926).

Described from specimens taken off the Karroo rat, *Paratomys brantsi* (= *Otomys brantsi*) at Deelfontein, Cape Province. It has also been recorded from *Mus. sp.* at Umfolosi, Zululand (Jordan & Rothschild, 1908), and from *Tatera lobengulae* (gerbille) and striped mouse, *Rhabdomys pumilo* (= *Arvicanthis pumilio*) near Bothaville, O.F.S. (Mitchell, 1921). Ingram (1927b) has recorded it from the following hosts: *T. lobengulae* at Standerton, Roberts Drift, Pyramid and Louis Trichardt in the Transvaal; the Barrage, Rendezvous, Frankfort, Knopiesfontein, Viljoen's Drift, and in the Ladybrand and Hoopstad Districts in the Orange Free State. *Desmodillus auricularis* Namaqua gerbille) at Bultfontein and Bloemfontein in the O.F.S., and in the Kimberley and Calvinia Districts, C.P.; *Paratomys luteolus* (eastern Karroo rat) at Steynsburg C.P.; *Myotomys broomi* (Broom's Karroo rat) in the Calvinia District, C.P., and *M. granti* (Grant's Karroo rat); *Leggada deserti* (desert dwarf mouse) at Villiers, O.F.S.; *Malacothrix typicus* (typical large-eared mouse) at Rendezvous, O.F.S.; *Otomys irroratus* (water rat) at Standerton; *Mastomys coucha*

(multimammate mouse) at Rendezvous, Greylings Rust, Weiveld Siding and the Barrage in the O.F.S.; *Cynictis penicillata* (yellow mongoose) at Blesboklaagte and Kroonspruit in the O.F.S.; *Suricata suricatta* (suricate) in the Frankfort District, O.F.S.; *Geosciurus capensis* (ground squirrel) at Rendezvous, O.F.S., and *Lepus capensis* (Cape hare) in the Calvinia District, Cape Province. He has also received specimens taken off *Lepus saxatilis* in South-West Africa. Ingram (1927b) has found this species to be capable of sucking human blood, and states that it is apparently able to transmit plague from infected rodents to non-infected rodents.

4. **Xenopsylla erilli** (Rothschild).

Pulex erilli Rothschild, *Nov. Zool.*, XI, p. 610, Pl. 8, f. 16, 17; Pl. 9, f. 22 (1904).

Loemopsylla erilli (Roths.) Jord. & Roths., *Parasit.*, I, p. 58, Pl. 2, f. 6, 15; Pl. 5, f. 2; Pl. 7, f. 5 (1908).

Xenopsylla erilli (Roths.) Jord., *Verhandl. III. Intern. Ent.-Kongr.* II, p. 622, f. 29, 80 (1926).

Described from specimens taken off stink muishond, *Ictonyx striata (= Zorilla striata)*, *Suricata suricatta (= S. tetradactyla)* and ground squirrel, *Geosciurus capensis (= Xerus capensis)* at Deelfontein, Cape Province. Ingram (1927b) has recorded it from *Cynictis penicillata* (yellow mongoose) and *S. suricatta* at Blesboklaagte, O.F.S.; *G. capensis* at the Barrage, Weiveld Siding and in the Bultfontein District, O.F.S. It has also been taken off *C. penicillata* near Bothaville, O.F.S. and *G. capensis* at Vryburg, C.P. Ingram (1927b) has found it to be capable of sucking human blood.

5. **Xenopsylla hamula** Jordan.

Xenopsylla hamula Jord. *Nov. Zool.*, XXXII, p. 99, f. 7 (1925).

Xenopsylla hamula Jord., *Verhandl. III. Intern. Ent.-Kongr.*, II. p. 611 (1926).

Described from specimens taken off dormouse, *Claviglis murinus (= Graphiurus murinus)* at Grahamstown, C.P.

6 **Xenopsylla hirsuta** Ingram.

Xenopsylla hirsuta Ingram, *Bull. Ent. Res.*, XVIII, iv, p. 372, f. 4B, 5, 6A (1928).

Described from numerous specimens of both sexes taken in the nests of *Tatera afra* (Cape gerbille) at Bellville, C.P. in March and April, 1926. Mr. De Meillon has received specimens taken off *Tatera lobengulae* (gerbille) at Wolseley, Klaver and Tulbagh Valley, C.P.; also off *Rhabdomys pumilio* (striped mouse) at Breede River and Worcester, C.P.

This species has been shown to be capable of transmitting plague from rodent to rodent in South Africa (Dept. of Ento., 1930).

7. **Xenopsylla lobengulae** De Meillon.

Xenopsylla lobengulae De Meillon, *Nov. Zool.*, XXXVI, p. 139, f. 1-10 (1930).

Described from specimens taken off *Tatera lobengulae* (gerbille) at Chavonnes, Worcester, C.P., 5th October, 1928.

8. **Xenopsylla piriei** Ingram.

Xenopsylla piriei Ingram, *Bull. Ent. Res.*, XVIII, iv, p. 371, f. 1A, 2A, 3A (1928).

Described from numerous males and females taken in the nests of *Tatera lobengulae* (gerbille) in the Transvaal, and from nests and burrows of Karroo rats *(Myostomys broomi* and *Paratomys luteolus)*, and off *Desmondillus auricularis* (Namaqua gerbille) in the Steynsburg and Calvinia Districts, C.P. in April, 1925 and September, 1926. Specimens have also been found on a gerbille between Pitsani and Hildavale, Bechuanaland Protectorate (B. de Meillon).

9. **Xenopsylla scopulifer** (Rothschild).

Pulex scopulifer Roths., *Nov. Zool.*, XII, p. 480, Pl. 13, f. 5 (1905).

Loemopsylla scopulifer (Roths.) Jord. & Roths., *Parasit.*, I, p. 52, Pl. 5, f. 1, 9 (1908).

Xenopsylla scopulifer (Roths.) Jord., *Verhandl. III. Intern. Ent.-Kongr.*, II, p. 612, f. 40, 52 (1926).

Described from specimens taken off *Saccostomus campestris* (Peter's pouched mouse) and golden rock mouse, *Praomys arborarius (= Mus auricomis)* at Umfolosi, Zululand, and off *Cricetomys gambianus* (giant rat) at Beira, Mozambique.

10 **Xenopsylla sulcata** Ingram.

Xenopsylla sulcata Ingram, *Bull. Ent. Res.*, XVIII, iv, p. 374, f. 4A, 6B, 7 (1928).

Described from males and females collected from the nests of *Tatera afra* (Cape tatera) at Citrusdale, C.P., September, 1927. It has also been found on *Tatera lobengulae* (gerbille) at Citrusdale, Breede River and Goudini Road in the Cape Province (B. De Meillon).

11. **Xenopsylla tortus** (Jordon and Rothschild).

Loemopsylla tortus Jord. & Roths., *Parasit.*, I, p. 53, Pl. 5, f. 4 (1908).

Xenopsylla tortus (J. & R.) Jord., *Verhandl. III. Intern. Ent.-Kongr.*, II, p. 612, Pl. 18, f. 41; Pl. 19, f. 58 (1926).

Described from specimens collected in Mozambique off *Cricetomys gambianus* (giant rat) and *Mus. sp.* Jordan (1908) records it off golden rock mouse, *Praomys arborarius (= Rattus auricomis)*, Kenya Colony.

12. **Xenopsylla trifarius** De Meillon.

Xenopsylla trifarius De Meillon, *Nov. Zool.*, XXXV, p. 250, f. 2-5 (1930).

Described from specimens, both sexes, collected in the nest of *Tatera lobengulae* (tatera) at Klaver, C.P. in July, 1928.

13. **Xenopsylla trispinus** Waterston.

Xenopsylla trispinus Waterst., *Proc. Roy. Phys Soc. Edin.*, XVIII, iii, p. 192, f. 1-6 (1911).

Xenopsylla trispinus (Waterst.) Jord., *Verhandl. III. Intern. Ent.-Kongr.*, II, p. 618, f. 74 (1926).

Described from specimens, both sexes, found on *Petrochelidon spilodera* (S.A. cliff swallow) at Emgwali, Dohne, Cape Province. We have found specimens in the nests of the same bird at Onderstepoort.

14. **Xenopsylla versuta** Jordon.

Xenopsylla versuta Jord., *Nov. Zool.*, XXXII, p. 100, f. 8 (1925).

Xenopsylla versuta Jord., *Verhandl. III. Intern. Ent.-Kongr.*, II, p. 616, Pl. 20, f. 67, 72 (1926).

Described from specimens taken off *Funisciurus sp.* in Angola. Jordan (1926) has also recorded it from *Paraxerus aruscensis*, Tanganyika Territory. Specimens have also been taken off *Rhabdomys pumilio* (striped mouse); north-east of Koro, Bechuanaland Protectorate, 8 May, 1930 (B. De Meillon).

Genus Ctenocephalides Stiles & Collins.

Ctenocephalus Kolenati, *Jahresb. Mähr.-Schles. Ges.*, p. 65 (1859). *nec.* Hawle and Corda, 1847 (Trilobite).

Ctenocephalides Stiles & Collins, Public Health Repts., XLV, 23, p. 1309 (1930).

This genus includes ten species and two varieties.

Genotype: *Pulex canis* Curtis.

Key to the South African Species.

1. Head less than twice as long as broad, with the frons strongly rounded 2
   Head slightly more than twice as long as broad, with the frons considerably less rounded; manubrium of clasper of ♂ narrow at apex ... ... *C. felis*
2. Hindtibia with 7 to 8 dorsal notches bearing stout setae; inclusive of apical notch; stigmata large (about 0·04 mm.) manubrium of clasper of ♂ widened at apex ... ... *C. canis.*
   Hindtibia with 6 dorsal notches bearing stout setae, inclusive of apical notch; stigmata smaller 3

3. Sternites III to VI of ♀ with 3 to 4 setae on each side; fore-tarsal segment V of ♂ with 5 thick spiniform setae on venter; manubrium of clasper of ♂ widened at apex ... ... *C. connatus.*
Sternites III to VI of ♀ with 2 setae on each side; fore-tarsal segment V of ♂ with 2 spiniform setae on venter; manubrium of clasper of ♂ narrower at apex *C. felis strongylus.*

1. **Ctenocephalides canis** (Curtis) Fig. 26E.

Pulex canis Curtis, *Brit. Ent.*, III, No. 114, f. A-E, 8 (1826).

Rothschild (1910) states that this species is practically cosmopolitan, but more abundant in temperate countries than in the tropics. It is a parasite of dogs, but also occurs on rats. We have taken it off dogs at Onderstepoort, but it is not nearly so common on these animals as *C. felis.* I have seen specimens in the South African Museum recorded by Waterston (1914) from blue duiker, *Philantomba monticola (=Cephalophus monticola).* It has also been recorded from several other wild animals in South Africa, but the specimens proved to be *C. connatus.* It has been shown to be capable of transmitting plague from rodent to rodent, and is a transmitting agent of *Tryanosoma lewisi* to rats; also a secondary host of *Dipylidium caninum, Hymenolepis diminuta, Dirofilaria immitis* and *Dipetalonema reconditum*, only the first named worm being known to occur in South Africa.

2. **Ctenocephalides connatus** (Jordan).

Ctenocephalus connatus Jordan, *Nov. Zool.*, XXXII, p. 98, f. 5 (1925).

Described from specimens taken off stink muishond, *Ictonyx striata (=Zorilla striata);* ruddy mongoose. *Myonax ratlamuchi (= Herpestes badius);* hedgehog, *Atelerix frontalis (= Erinaceus europaeus)* and springhare *(Pedetes caffer)* at Deelfontein, C.P.; ground squirrel, *Geosciurus capensis (= Xerus capensis)* and yellow mongoose *(Cynictis penicillata)* at Bothaville, O.F.S.; *Suricata suricatta* at Grahamstown, C.P.; also off *Lepus* in Tanganyika Territory. Ingram (1927b) has recorded it under the name of *C. canis* from the following hosts: *C. penicillata* at Thopjies and the Frankfort and Kroonstad Districts, O.F.S.; *S. suricatta* at the Barrage, Hoopstad, Blesboklaagte and in the Bultfontein District in the Orange Free State; *G. capensis* at the Barrage and in the Bultfontein and Kroonstad Districts, O.F.S.; *Lepus capensis* (Cape hare) in the Calvinia District, C.P. We have taken it off *S. suricatta* near Pretoria, and *A. frontalis* at Onderstepoort. In the laboratory collection there are also specimens taken off the following hosts: *G. capensis* and *Thos mesomelas* (black-backed jackal) at Vryburg, C.P. (coll. P. L. le Roux, and G.A.H.B.); *Felis ocreata caffra* (Cape wild cat) and *Genetta rubiginosa* (rusty-spotted genet) in the Rustenburg District, Transvaal; *Lycaon pictus venaticus* (Cape hunting dog) and *Sylvicapra grimmi* (Cape duiker) in the Umfolosi Reserve, Zululand (coll. Austin Roberts and P. L. le Roux).

3. **Ctenocephalides felis** (Bouché) Fig. 26D.

Pulex felis Bouché, *Nov. Acta. Acad. Leop. Carol.*, XVII, p. 505 (1835).

A common and widely distributed flea throughout the world on cats, dogs and other animals. It is a common parasite on dogs and cats in the Pretoria District, and specimens have been taken off a cat at Maritzburg, Natal (coll. Laurence Hill). Waterston (1914) has recorded it taken off blue duiker, *Philantomba monticola (=Cephalophus monticola)*. In the laboratory collection there are specimens taken off *Felis ocreata caffra* (Cape wild cat) and *Lepus zuluensis* in the Rustenburg District, Transvaal. It is a secondary host of *Dipylidium caninum*, *Dirofilaria immitis* and *Dipetalonema reconditum*, only the first named worm being known to occur in South Africa.

3A. **Ctenocephalides felis strongylus** (Jordan).

Ctenocephalus felis strongylus Jordan, *Nov. Zool.*, XXXII, p. 98 (1925).

Described from a large number of specimens taken off many different hosts in numerous localities from French West Africa and the Sudan to South Africa. Type off *Canis lateralis*, Kenya Colony. Specimens have been taken off *Myonax pulverulentus* (grey mongoose), Kenkelbosch, C.P. (coll. L. Hill), and *Genetta tigrina* in the Albany District, C.P.

Genus Ceratophyllus Curtis (1832).

This genus contains a large number of species found in many parts of the world, many of them being parasitic upon birds.

Key to the South African Species.

1. ♂: Exopodite not extending much above the process of clasper, with two strong setae of which the upper one stands halfway between apex and lower one; ♀: apex of sternite VII obliquely rounded, without projecting lobe ... ... *C. fasciatus.*

   ♂: Exopodite extending much beyond the apex of the process of the clasper, its upper seta much nearer to the lower one than to the apex; ♀: apex of sternite VII produced into a truncate lobe, below which the segment is sinuate ... ... *C. londiniensis.*

1. **Ceratophyllus fasciatus** (Bosc.) (1801), Fig. 26F.

Ceratophyllus fasciatus (Bosc.) Roths., *Bull. Ent. Res.*, I, p. 94, f. 18, 20 (1910).

Ceratophyllus fasciatus (Bosc.) Jord. & Roths., *Ectoparasites*, I, iii, p. 180, f. 165a, 165b, 166 (1921).

Jordan and Rothschild (1921) recorded two ♀♀ collected at Capetown, C.P., on the brown rat, *Rattus norvegicus (=Epimys decumanus)*, and Ingram (1927b) has recorded specimens from *Rattus rattus*, Johannesburg. It has also been recorded taken off *R. norvegicus* and other small mammals in

Europe, Asia, North America and Australia. It readily bites man. It has been shown to be capable of transmitting plague from rodent to rodent and is a transmitting agent of *Trypanosoma lewisi* to rats; also a secondary host of *Hymenolepis diminuta* and *H. microstoma*, but these tapeworms are not known to occur in South Africa.

2. **Ceratophyllus londiniensis** Rothschild.

Ceratophyllus italicus Tirab. (1904).

Ceratophyllus londiniensis Roths., *Bull. Ent. Res.*, I, p. 94, f. 17, 19 (1910).

Ingram (1927b) has recorded specimens taken off *Rattus rattus* at Johannesburg. It also occurs on rats in Europe.

Genus Stivalius Jordan and Rothschild.

Stivalius Jordan and Rothschild, *Ectoparasites*, I, iv, p. 249 (1922).

This genus contains seventeen species found on rodents and marsupials in Africa, Asia and Australia. Three species have been recorded from South Africa.

Genotype: *Ceratophyllus ahalae* Rothschild.

Key to the South African Species.

1. Males 2
   Females 4
2. Ninth sternite with lateral subapical process 3
   Ninth sternite without lateral subapical process ... *S. afer.*
3. Paramere of penis with simple claw and a dorsal hump *S. ahalae.*
   Paramere of penis with double claw and a dorsal hump *S. aporus.*
4. Ventral angle of eighth tergite produced, acuminate 5
   Ventral angle of eighth tergite rounded off ... ... *S. afer.*
5. Head of receptaculum seminis strongly humped dorsally *S. ahalae.*
   Receptaculum seminis less humped; the stout outer dorsal setae between middle and apex of hind tibia forming an almost regular comb ... ... *S. aporus.*

1. **Stivalius afer** Rothschild.

Pygiopsylla afer Roths., *Proc. Zool. Soc. Lond.*, p. 618 (1908).

Stivalius afer Jord. and Roths., *Ectoparasites*, I, iv, p. 250 (1922).

Described from specimens collected at Benguella and Dalla Tando in Angola; in the latter locality from *Arricanthis rufinus.*

2. **Stivalius ahalae** (Rothschild).

♂. *Ceratophyllus ahalae* Roths., *Nov. Zool.*, XI, p. 631, Pl. 11, f. 51, Pl. 12, f. 55, Pl. 13, f. 60 (1904).

♂. *Pygiopsylla ahalae* Roths., *Proc. Zool. Soc. Lond.*, p. 617 (1908).

♂.♀. *Stivalius ahalae* (Roths.) Jord. & Roths., *Ectoparasites*, I, iv, p. 252, f. 242, 244 (1922).

This species has been found in India on *Rattus rattus* and *Sciurus palmarum*. Jordan and Rothschild (1922) has also recorded a male taken off Brant's mouse, *Myomys colonus* (= *Mus colonus*) at Mfongosi, Zululand, which differs very slightly from the type.

3. **Stivalius aporus** Jordan and Rothschild.

Stivalius aporus Jord. & Roths., *Ectoparasites*, I, iv, p. 254, f. 246 (1922).

Described from specimens taken off several hosts in India and Ceylon. One male is also recorded taken off Brant's mouse, *Myomys colonus* (= *Mus colonus*) at Mfongosi, Zululand, which like the last also differs very slightly from the type.

Genus Praopsylla Ingram.

Praopsylla Ingram, *Bull. Ent. Res.*, XVII, iii, p. 292 (1927).

This genus contains a single species.

1. **Praopsylla powelli** Ingram.

Praopsylla powelli Ingram, *Bull. Ent. Res.*, XVII, iii, p. 293, f. 4 (1927).

Described from two ♀♀ taken off *Praomys arborarius* (golden rock mouse) at Lickeroog, Calvinia District, C.P., July, 1926.

Genus Chiastopsylla Rothschild.

Chiastopsylla Rothschild, *Ent.*, XLIII, No. 563, p. 105 (1910).

This genus contains seven species and one variety found exclusively in South Africa on Muridae.

Genotype: *Ceratophyllus numae* Rothschild.

Key to the Species.

1. Males (male of *C. octavii* unknown) 2
   Females 8
2. Sternite IX with scales on distal margin 3
   Sternite IX with setae only on distal margin 5
3. Four pairs of scales on sternite IX, the scales equal and narrow ... ... *C. quadrisetis.*
   Three pairs of scales on sternite IX, scales wider 4

4. Sternite VIII finger-like distally; scales on sternite IX diamond-shaped, equal and acutely pointed ... *C. numae.*

Sternite VIII wedge-shaped; scales on sternite IX dissimilar, the uppermost broad, subquadrate, the second deeply and roundly emarginate distally, the third longest, pointed and spatulate ... ... *C. rossi.*

5. Genal spines absent (may be rudimentary in *pitchfordi*); internal plate of penis considerably longer than the manubrium 6

Gena spines present; internal plate of penis shorter than the manubrium ... ... *C. godfreyi.*

6. Vertical area of sternite IX triangular, the posterior margin almost straight with a tuft of four or five setae on its postero-ventral margin 7

Posterior margin of sternite IX rounded without such a tuft of setae ... ... *C. pitchfordi.*

7. Sternite VIII with a subapical ventral tuft of five to seven curved setae and one or more straight ones; longest seta of first hind tarsus reaching to apex or slightly beyond apex of second tarsus, the longest seta of second tarsus reaching to apex or slightly beyond apex of the fourth *C. mulleri.*

The curved subapical setae do not form so distinct a tuft, being more equally spaced along margin of the sternite; longest seta on first hind tarsus reaching to three-quarters the length of the fifth tarsus, and the longest seta on the second hind tarsus reaching to apex of fifth segment ... ..., ... *C. mulleri longisetis.*

8. Incrassation on head separating the frons from the occiput ... 9

Incrassation on head absent; sternite VII with distal margin evenly rounded ... ... *C. octavii.*

9. Genal spines present; teeth of pronotal comb as long as or longer than the pronotum 10

Genal spines absent (may be rudimentary in *pitchfordi*); teeth of pronotal comb shorter than the pronotum; sternite VII with distal margin evenly rounded 13

10. Sternite VII with distal margin evenly rounded; median row of setae on mesonotum not reaching as far down as the postmedian row; spines present on tergites I-IV *C. quadrisetis.*

Sternite VII either incised or with a small rounded median lobe on the distal margin 11

11. Sternite VII with distal margin incised 12

Sternite VII with median lobe on distal margin, spines present on metanotum and tergites I-IV; median row of setae on mesonotum extending down as far as the postmedian row ... ... *C. rossi.*

12. Sternite VIII with about a dozen setae on its ventral half, not including those on the posterior margin; spines present on metanotum and tergites I-IV; median row of setae on mesonotum extending down as far as the postmedian row ... ... *C. numae.*
    Sternite VIII nearly bare ventrally; spines absent on metanotum and tergites I-IV ... ... *C. godfreyi.*
13. Tergite VII with a pointed lobe on its distal margin external to the antepygidial seta ... ... *C. pitchfordi.*
    Tergite VII with a less prominent and more rounded lobe ... ... *C. mulleri and var. longisetis.*

1. **Chiastopsylla godfreyi** Waterston.

♂. *Chiastopsylla godfreyi* Waterst., *Proc. Roy. Phys. Soc. Edin.*, XIX, i, p. 8, f. 1-3 (1913).

♀. *Chiastopsylla godfreyi* Waterst., *Trans. Ent. Soc.*, Lond., Pts. 3-5, p. 414, f. 1 (1920).

Described from a single male taken off striped mouse, *Rhabdomys pumilo (=Arricanthis pumilio)* on the Pirie Mountains, near Kingwilliamstown, C.P., and from two females collected at Grahamstown, C.P. One ♂ taken off *Praomys namaquensis grahami* (Albany rock mouse), near Grahamstown, C.P. (coll. Austin Roberts).

2. **Chiastopsylla mulleri** Ingram.

Chiastopsylla mulleri Ingram, *Bull. Ent. Res.*, XVII, iii, p. 291, f. 2a, 3 (1927).

Described from numerous males and females collected in the nests of *Mystomys broomi* (Karroo rat) at Calvinia, C.P., in July and August, 1926. Specimens have also been taken off *Tatera lobengulae* (gerbille), Klaver, C.P., and *Paratomys luteolus* (Karroo rat), Doorn River, Klaver and Tulbagh, C.P. (coll. C. V. Muller; det. B. De Meillon).

2A. **Chiastopsylla mulleri longisetis** Ingram.

Chiastopsylla mulleri var. longisetis Ingram, *Bull. Ent. Res.*, XVII, iii, p. 292 (1927).

The females are indistinguishable from those of *C. mulleri*. Specimens were collected in the nests of *Mystomys broomi* (Karroo rat) at Zak River, 60 miles north of Calvinia, C.P., in August, 1926.

3. **Chiastopsylla numae** (Rothschild).

Ceratophyllus numae Roths., *Nov. Zool.*, XI, p. 637 (1904).

Described from specimens taken off the Karroo rat, *Paratomys brantsi (= Otomys brantsi)* at Deelfontein, Cape Province. We have taken specimens off *Otomys irroratus* (water rat), *Mastomys coucha* (multimammate mouse) and *Thallomys moggi* (Mogg's rat) at Onderstepoort. Mr. De Meillon has received specimens taken off *Paratomys luteolus*, Klaver, C.P. (coll. C. V. Muller).

4. **Chiastopsylla octavii** (Rothschild).

Ceratophyllus octavii Roths., *Nov. Zool.*, XI, p. 638 (1904).

Described from two ♀♀ taken off Cape dormouse, *Claviglis ocularis (= Graphocularis biurus)* at Deelfontein, C.P. Mitchell (1921) records it taken off striped mouse, *Rhabdomys pumilio (=Arricanthis pumilio)* near Bothaville, O.F.S. We have taken a ♀ off *Praomys namaquensis monticularis* (rock mouse) at Onderstepoort, 1st August, 1927.

5. **Chiastopsylla pitchfordi** Ingram (Fig. 25).

Chiastopsylla pitchfordi Ingram, *Bull. Ent. Res.*, XVII, iii, p. 289, f. 1, 2b (1927).

Described from specimens collected in nests of *Paratomys luteolus* (Karroo rat) at Steynsburg, C.P., October, 1925. Ingram (1927b) has also recorded it from *Myotomys granti* (Grant's Karroo rat).

6. **Chiastopsylla quadrisetis** De Meillon.

Chiastopsylla quadrisetis De Meil., *Nov. Zool.*, XXXV, p. 251, f. 6-8 (1930).

Described from specimens taken from nests of *Paratomys luteolus* (Karroo rat), Klaver, C.P., August, 1928.

7. **Chiastopsylla rossi** (Waterston), Fig. 26G.

Ceratophyllus rossi Waterst., *Ent. Mo. Mag.* (2) XX, p. 271, Pl. 5, f. 3, 4 (1909).

Described from a single ♀ taken off black rat, *Rattus rattus (= Mus rattus)* at Pirie, Kingwilliamstown, C.P. Waterston (1915) has also recorded it taken from *Rattus rattus*, *Otomys irroratus* (African water rat), *Crocidura flavescens* (red shrew) and *Mystromys albicaudatus* (white-tailed rat) at Grahamstown, C.P. Ingram (1927b) has recorded it from the following hosts: *Cynictis penicillata* (yellow mongoose), Bothaville, O.F.S. *Suricata suricatta* in the Frankfort, Ladybrand and Parys Districts, O.F.S. *Tatera lobengulae* (gerbille) in the Frankfort District and at the Barrage, O.F.S., and at Randfontein and Sundra in the Transvaal. *Myotomys broomi* and *M. granti* (Karroo rats) in the Calvinia District, C.P. *Paratomys luteolus* (eastern Karroo rat) at Steynsburg, C.P. *Mystromys albicauratus* (white-tailed rat) at the Barrage and Weiveld Siding in the O.F.S. *Rhabdomys pumilio* (striped mouse), Randfontein, Transvaal, and Cape Flats. *Mastomys coucha* (multimammate mouse) in the Heilbron District and Barrage, O.F.S. Specimens have also been received by Dr. Ingram taken from *Tatera afra* (Cape gerbille) at Bellville, C.P. Mr. De Meillon has received specimens taken off *Paratomys luteolus*, Tulbagh, C.P. (coll. C. V. Muller); *Otomys irroratus*, Breede River, C.P. (coll. T. Muller) and *Rhabdomys pumilio*, Breede River, Goudini Road and Worcester, C.P. Specimens have also been taken off *O. irroratus*, Uitenhage District, C.P., and Onderstepoort, and *Aethomys chrysophilus* (African rat), Sycamore, Transvaal (coll. G.A.H.B.). Ingram (1927b) has found this species to be capable of sucking human blood.

Genus Listropsylla Rothschild.

Listropsylla Rothschild, *Ent. Mo. Mag.* (2), XVIII, p. 175 (1907).
Listropsylla Jordan, *Nov. Zool.*, XXXVI, p. 130 (1930).

This genus contains seven species and one variety occurring only in Africa. The species are mainly parasitic upon *Muridae*.

Genotype: *Ceratophyllus agrippinae* Rothschild.

Key to the South African Species (after Jordan).

1. Segment II of antenna apically rounded-enlarged, some of its setae reaching to apex of club or even beyond. Pygidium with 30 or more grooves on each side. ♂: body of clasper much shorter than long, its dorsal bay small, about as large as dorsal apical process; exopodite broad, of nearly even width, its long ventral seta slender, subventral. ♀: tail of spermatheca longer than head 2
   Segment II of antenna not enlarged, its setae reaching at most to middle of club. Pygidium with 21 or fewer grooves on each side 3

2. Tergites II to VII with at least one, usually two, setae more ventral than stigma. ♂: lower apical angle of clasper produced. ♀: nearly always with 4 antepygidial setae *L. agrippinae.*
   Tergites V and VI at most with one, VII with no seta more ventral than stigma. ♂: lower apical angle of clasper not produced distad. ♀: 3 antepygidial setae. *L. vicinus.*

3. Tergite I with fewer than 30 apical spines. ♂: body of clasper longer than broad, the dorsal bay wide; exopodite strongly narrowing towards both apex and base, its long ventral seta at two-thirds (approximately). ♀: tail of spermatheca shorter than head 4
   Tergite I with 40 or more apical spines. ♂: dorsal apical process of clasper triangular, large, very much larger than ventral apical projection, a row of setae along apical margin of clasper. ♀: head of spermatheca longer than tail, globular; no double sclerite behind ring of bursa copulatrix; stylet as long as hindtarsal segment III 5

4. Midtarsal segment I twice as long as V. Pygidium with 18 to 21 grooves on each side. ♂: ventral apical process of clasper at most thrice as long as broad. ♀: head of spermatheca irregularly elliptical ... ... *L doriрpae.*
   Midtarsal segment I less than twice as long as V. Pygidium with 16 to 17 grooves on each side. ♂: ventral apical process of clasper at least four times as long as broad. ♀: head of spermatheca subglobular ... *L. prominens.*

5. Pygidium with 19 to 24 grooves on each side. ♂: body of clasper below densely striated transversely. ♀: 4 to 6 setae below stigma on basal area of tergite VIII
L. chelura.

Pygidium with 21 to 24 grooves on each side. ♂: body of clasper below not striated. ♀: 7 to 10 setae below stigma on basal area of tergite VIII ... ... *L. cerrita.*

1. **Listropsylla agrippinae** (Rothschild).

♂♀ *Ceratophyllus agrippinae* Roths., *Nov. Zool.*, XI, p. 634, Pl. 12, f. 56, 57: Pt. 13, f. 62, 64 (1904).

♂♀ *Listropsylla agrippinae* (Roths.) Jordan, *ibid.*, XXXVI, p. 131 (1930).

Described from specimens taken off Karroo rats, *Paratomys brantsi (= Otomys brantsi)* and *Myotomys unisulcatus (= O. unisulcatus)* at Deelfontein, Cape Province. Ingram (1927b) has recorded it from the following hosts: *Myotomys broomi* and *M. granti* (Karroo rats) in the Calvinia District, C.P.; *Paratomys luteolus* (eastern Karroo rat) at Steynsburg, C.P., and *Rhabdomys pumilio* (striped mouse) at Bellville, C.P. Dr. Ingram has also received specimens taken from *Tatera afra* (Cape gerbille), Bellville, C.P., and *Aethomys chrysophilus* (African rat), Gobabis, S.W.A. Waterston (1915) records it from *Mystromys albicaudatus* (white-tailed rat), Grahamstown, C.P. We have received specimens taken off *Otomys irroratus* (water rat), *Myonax cauui* (slender mongoose) and nest of *Rhabdomys pumilio* in the Uitenhage District, C.P.; also from *Myotomys turneri*, Wakkerstroom, Transvaal (coll. Austin Roberts). One female taken off *Praomys namaquensis grahami* (rock mouse) at Grahamstown, C.P., 28th September, 1914 (coll. J. Hewitt; det. J. Waterston). Mr. De Meillon has received specimens taken off *Tatera lobengulae* (gerbille), Klaver, C.P. (coll. C. V. Muller); *Paratomys luteolus*, Klaver and Tulbagh, C.P. (coll. C. V. Muller); *Rhabdomys pumilio*, Breede River and Goudini Road, C.P. (coll. T. Muller), and *Otomys irroratus*, Breede River (coll. T. Muller).

2. **Listropsylla cerrita** Jordan.

♂♀ *Listropsylla cerrita* Jordan, *Nov. Zool.*, XXXVI, p. 136, f. 6, 7 (1930).

Described from specimens from nests of Karroo rats, *Myotomys broomi* and *Paratomys luteolus* on side of mountain, Klaver, Doorn River, C.P.

3. **Listropsylla chelura** Rothschild.

♂♀ *Listropsylla chelura* Roths., *Ent. Mo. Mag.* (2), XXIV, p. 207, Pl. 5, f. 1, 2 (1913).

♂♀ *Listropsylla chelura* (Roths.) Jordan, *Nov. Zool.*, XXXVI, p. 135 (1930).

Described from two males taken off striped mouse, *Rhabdomys pumilio (= Arvicanthis pumilio)* at Pirie, Kingwilliamstown, Cape Province, and one female from the same locality

off *Myosorex tenuis* (least brown-footed shrew). Jordan (1930) has also recorded specimens from *Arvicanthis* and *Tatera lobengulae* (gerbille), Belville, C.P. Mr. De Meillon has received specimens taken off *Otomys irroratus* (African water rat) and *R. pumilio*, Breede River, C.P. (coll. T. Muller).

4. **Listropsylla dorippae** (Rothschild), Fig. 26H.

♀ *Ceratophyllus dorippae* Roths., *Nov. Zool.*, XI, p. 636 (1904).

♂ ♀ *Listropsylla dorippae* (Roths.) Jordan, *ibid.*, XXXVI, p. 132 (1930).

Described from females taken off Karroo rat, *Paratomys brantsi (= Otomys brantsi)*, Deelfontein, Cape Province. Recorded by Mitchell (1921) as *L. stygius* from the following hosts near Bothaville, O.F.S.: Desert dwarf mouse, *Leggada deserti (= L. sp.)*; large-eared mouse, *Malacothrix typicus (= M. sp.)*; Cape fat mouse, *Steatomys krebsi (= S. sp.)*; *Tatera lobengulae* (gerbille), and *Cynictis penicillata* (yellow mongoose). Also recorded by Ingram (1927b) as *L. stygius* from *Tatera lobengulae*, Randfontein and Pyramid in the Transvaal. Dr. Ingram received specimens taken off *Myotomys broomi* (Broom's Karroo rat) in the Calvinia District, C.P.

5. **Listropsylla prominens** Jordan.

♂ ♀. *Listropsylla prominens* Jordan, *Nov. Zool.*, XXXVI, p. 133, f. 3-5 (1930).

Described from specimens taken off multimammate mouse, *Mastomys coucha (= Rattus coucha)*; African rat, *Aethomys chrysophilus (= Rattus chrysophilus)* and *Leggada minutoides* (dwarf mouse) at Mfongosi, Zululand.

6. **Listropsylla vicinus** (Rothschild).

♂ ♀. *Ceratophyllus vicinus* Roths., *Nov. Zool.*, XII, p. 484, Pl. 13, f. 7 (1905).

♂ ♀. *Listropsylla vicinus* (Roths.) Jordan, *ibid.*, p. 132 (1930).

Described from a male and female taken off the ruddy mongoose, *Myonax ratlamuchi* (=*Herpestes badius*) at Wakkerstroom, Transvaal.

Genus Ctenophthalmus Kolenati.

Ctenophthalmus Kolenati, *Parasit. Chiropt.*, p. 33 (1856).

This genus contains a number of species found on rats and mice.

1. **Ctenophthalmus ansorgei** Rothschild.

Ctenophthalmus ansorgei Roths., *Nov. Zool.*, XIV, p. 330 (1907).

Described from specimens collected at Bihé, Angola, off mole-rat, *Cryptomys bocagei* de Wint. (= *Goerychus bocagei*).

2. **Ctenophthalmus calceatus** Waterston.

♀. *Ctenophthalmus calceatus* Waterst., *Ent. Mo. Mag.* (2), XXIII, p. 27 (1912).

♂. *Ctenophthalmus calceatus* Roths., *ibid.* (2), XXIV, p. 208 (1913).

Described from one ♀ taken off striped mouse, *Rhabdomys pumilio* (= *Arvicanthis pumilio*), Pirie Mountains, near Kingwilliamstown, C.P., and two ♂♂ taken off the same host in the same locality. Ingram (1927b) records taking three specimens in a nest of *Tatera lobengulae* (gerbille) at Randfontein, Transvaal.

This species is closely allied to *C. ansorgei* Roths. The ♀ also resembles that of *C. triodontis* Roths. (Nov. Zool., XIV, p. 330, f. 3, 4, 1907).

Genus Dinopsyllus Jordan and Rothschild.

Dinopsyllus Jord. & Roth., *Nov. Zool.*, XX, iii, p. 561 (1913).

This genus contains eleven large species and one variety, mostly parasitic upon rats and mice. It is confined to Africa south of the Sahara. The species have the surface of the body with dorso-ventral lines.

Genotype: *Ctenopsyllus ellobius* Rothschild.

Key to the South African Species.

1. 0 to 2 genal spines ... ... *D. ingens.*
   Five genal spines 2
2. Vestigial frontal tubercle at or below centre of frons 3
   Vestigial frontal tubercle above centre of frons 5
3. Pronotum with two rows of setae, comb with 26 to 30 spines, these about two-thirds the length of pronotum; ♂: ventral armature of penis truncate; ♀: sternite VI with 24 to 34 setae; sternite VII with 55 to 69 setae (two sides together); sternite VIII with 25 to 39 setae on outer side below stigma 4
   Pronotum with three rows of setae, comb with 31 to 32 spines, less than two-thirds the length of pronotum; ♂: ventral armature of penis acuminate, strongly curved; ♀: sternite VI with 35 to 44 setae; sternite VII with 63 to 80 setae (two sides together); sternite VIII with 35 to 46 setae on outer side below stigma ... ... *D. tenax.*
4. ♂: apical margin of sternite VIII strongly rounded subapically ... ... *D. ellobius ellobius*
   ♂: apical margin of sternite VIII truncate-emarginate subventrally ... ... *D. ellobius abaris.*
5. ♂: combs on second and third tergites with eight or more spines; ♀: metepimerum with more than 28 setae; first tergite without spines ... ... *D. longifrons.*
   ♂: combs on second and third tergites with six or less spines; ♀: metepimerum with less than 26 setae *D. lypusus.*

1. **Dinopsyllus ellobius ellobius** (Rothschild).

Ctenopsyllus ellobius Rothschild, *Nov. Zool.*, XII, p. 490 (1905).

Described from specimens taken off *Crocidura flavescens* (red shrew) at Wakkerstroom, Transvaal, and off *Mus. sp.* at Sibudeni, Zululand. Waterston (1915) has also recorded it from *Mystromys albicaudatus* (white-tailed rat), Grahamstown, C.P. Specimens have also been taken off *Otomys irroratus* at Grahamstown (coll. J. Hewitt; det. J. Waterston), and *Rhabdomys pumilio* (striped mouse) at Worcester, C.P. (B. De Meillon).

1A. **Dinopsyllus ellobius abaris** Jordan.

Dinopsyllus ellobius abaris Jord., *Nov. Zool.*, XXXVI, p. 129, f. 1 (1930).

Described from specimens taken off *Arvicanthis*, at Klaver, Doorn River, and Breede River, Cape Province.

2. **Dinopsyllus ingens** (Rothschild).

Typhlopsylla ingens Roths., *Ent. Rec.*, XII, p. 37, Pl. 2, f. 4 (1900).

Described from specimens taken off Cape dune mole, *Bathyergus suillus (= B. maritimus)* in the Cape Province. Waterston (1914) has recorded it " probably from porcupine ". Dr. Ingram received specimens from the Cape Flats taken off *Cryptomys capensis* (Cape blesmol).

3. **Dinopsyllus longifrons** Jordan and Rothschild.

Dinopsyllus longifrons Jord. & Roths., *Nov. Zool.*, XX, iii, p. 566 (1913).

Described from specimens taken off the following hosts in Kenya Colony and Uganda: *Tachyoreytes audax*, *Otomys irroratus elgonis*, *Thamnomys sp.*, *Arvicanthis abyssinicus rubescens*, *Epimys sp.*, *Lophuromys sp.*, and *Oenomys sp.*

In the laboratory collection there are specimens taken off *Otomys irroratus* (African water rat) and *Mastomys coucha* (multimammate mouse), and from a nest of *Rhabdomys pumilio* (striped mouse) in the Uitenhage District, Cape Province. Specimens have also been taken off *Paratomys luteolus* (Karroo rat), Steynsburg, C.P., and off *Rhabdomys pumilio* on the Cape Flats (A. Ingram); also from *Tatera lobengulae* (gerbille) near Bothaville, Orange Free State, and a female from *Rattus rattus* (black rat) at Onderstepoort. Mr. De Meillon has received specimens taken off *R. pumilio*, Goudini Road and Breede River, C.P. (coll. T. Muller) and off *O. irroratus* and *T. lobengulae*, Breede River.

4. **Dinopsyllus lypusus** Jordan and Rothschild (Fig. 26I).

Dinopsyllus lypusus Jord. & Roths., *Nov. Zool.*, XX, iii, p. 570 (1913).

Dinopsyllus apistus Jord. & Roths., *ibid.*, p. 569 (1913), ♀ only.

Described from specimens collected in Kenya Colony and Uganda off several hosts belonging to the following genera: *Nasilio*, *Epimys*, *Arricanthis*, *Lophuromys*, *Otomys*, *Oenomys*, and *Dasymys*.

Mitchell (1921) records it from the following hosts near Bothaville, Orange Free State: *Tatera lobengulae* (gerbille); multimammate mouse, *Mastomys coucha* (= *Rattus coucha*); striped mouse, *Rhabdomys pumilio* (= *Arvicanthis pumilio*), and large-eared mouse, *Malacothrix typicus* (= *M. sp.*). Ingram (1927b) has recorded it from the following hosts: *Geosciurus capensis* (Cape ground squirrel) at the Barrage, Vaal River, and in the Kroonstad District, O.F.S. *Desmodillus auricularis* (Namaqua gerbille) at Bloemfontein, O.F.S., and in the Kimberley District, C.P. *Tatera lobengulae* at Standerton, Robert's Drift, Sundra, Randfontein, Pyramid and Elim Hospital, in the Transvaal; at Viljoen's Drift, the Barrage, Weiveld Siding, and in the Kroonstad, Frankfort, Ladybrand, Heilbron and Hoopstad Districts in the Orange Free State. *Streatomys krebsi* (Cape flat mouse) at the Barrage, O.F.S. *Otomys irroratus* at Standerton, Transvaal, and Viljoen's Drift, O.F.S. *Mystromys albicaudatus* (white-tailed rat) at the Barrage, Weiveld Siding and in the Frankfort District, O.F.S. *Leggada deserti* (desert dwarf mouse) at Villiers, O.F.S., and Standerton, Transvaal. *Rhabdomys pumilio* on the Cape Flats. *Mastomys coucha* at Weiveld Siding, the Barrage and Knopiesfontein in the O.F.S., and at Randfontein, Transvaal; also from *Myotomys granti* (Grant's Karroo rat). Specimens have also been received by Dr. Ingram taken off *Tatera afra* (Cape gerbille) on the Cape Flats. The author found this species on *Aethomys chrysophilus* (African rat), *Mastomys coucha* and *Lemniscomys spinalis* (bushveld striped mouse) at Sycamore, Eastern Transvaal, in October and November, 1927. Mr. De Meillon received specimens taken off *Paratomys luteolus* (Karroo rat) at Tulbagh, C.P. (coll. C. V. Muller).

Ingram (1927b) has found this species to be capable of sucking human blood, and has demonstrated that it can transmit plague from infected rodents to uninfected rodents.

5. **Dinopsyllus tenax** Jordan.

♂♀. *Dinopsyllus tenax* Jordan, *Nov. Zool.*, XXXVI, p. 130, f. 2 (1930).

Described from specimens taken from nests of the Karroo rats, *Myotomys broomi* and *Paratomys luteolus* at Klaver, Doorn River, C.P.; also from Karroo rats, Breede River, C.P.

Genus Hypsophthalmus Jordan and Rothschild.

Hypsophthalmus Jord. & Roths., *Nov. Zool.*, XX, iii, p. 578 (1913).

This genus contains three African species, two of which have been found in South Africa.

Genotype: *Hypsophthalmus campestris* Jordan & Rothschild.

1. **Hypsophthalmus aganippes** (Rothschild).

Ctenopsyllus aganippes Rothschild, *Nov. Zool.*, XI, p. 647 (1904).

Described from specimens taken off *Mus. sp.* at Deelfontein, Cape Province. Ingram (1927b) has recorded it from *Myotomys broomi* (Broom's Karroo rat) in the Calvinia District, Cape Province. Specimens have been received by Mr. De Meillon taken off *Paratomys luteolus* (Karroo rat) at Doorn River, Klaver, C.P. (coll. C. V. Muller).

2. **Hypsophthalmus granti** (Rothschild), Fig. 26J.

Ctenopsyllus granti Roths., *Nov. Zool.*, XI, p. 646 (1904).

Described from specimens taken off Karroo elephant-shrew, *Macroscelides proboscideus (= Macro proboscideus)* at Deelfontein, Cape Province. Dr. Ingram has received specimens taken off the same host at Onderste Doorns, C.P., and from an elephant-shrew at Williston, C.P.

Genus LEPTOPSYLLA Jordan and Rothschild.

Ctenopsyllus Kolenati (1862), *nec Kolenati* (1856).

Leptopsylla Jord. & Roths., *Nov. Zool.*, XVIII, i, p. 85 (1911).

Genotype: *Ctenopsyllus musculi* (Dugès).

1. **Leptopsylla segnis** (Schönh) (Fig. 26K).

Pulex segnis Schönh, *Kon. Vet. Nya Handb.* (1816).

Pulex musculi Dugès, *Ann. Sci. Nat.*, XXVII, p. 160 (1832).

This species can be identified by the presence of two short, curved spines near the front angle of frons. Rothschild (1910) states that it is widely distributed, and is very common on rats and mice, especially *Mus musculus* (house mouse), with which it has spread. It occasionally bites man. Waterston (1915) has recorded it from the black rat, *Rattus rattus (= Mus rattus)* at Grahamstown, Cape Province. Ingram (1927b) has recorded it taken off *Rattus rattus* at Johannesburg and Standerton, in the Transvaal; East London, C.P., and Durban, Natal; also from *Tatera lobengulae* (gerbille) at Standerton. We have taken it off *R. rattus* at Onderstepoort and Mr. De Meillon has received specimens taken off the same host at Vryburg and Port Elizabeth, C.P. (coll. Dr. Gray). It has also been taken off *Rattus norvegicus* (brown rat) at Pietermaritzburg, Natal (coll. L. Hill). It has been shown to be capable of transmitting plague from rodent to rodent. It is also a secondary host of the exotic worm, *Hymenolepis diminuta.*

Family ISCHNOPSYLLIDAE.

This family, formally known as Ceratopsyllidae, contains a number of species found on bats.

Key to the South African Genera.

1. Maxillae sharp pointed, or acuminate at the lower distal angle; head and prothorax very short, the former higher than long, semicircular ... ... *Thaumapsylla.*
   Maxillae truncate, lower distal angle not acuminate, or only slightly so 2
2. Abdomen with combs ... ... *Ischnopsyllus.*
   Abdomen without combs, but minute spines may be present 3
3. Occiput with dorsal incrassations; posterior margin with several short, stout, pointed spine-like setae behind antennal groove ... ... *Araeopsylla.*
   Occiput without dorsal incrassations ... *Rhinolophopsylla.*

Genus Thaumapsylla Rothschild.

Thaumapsylla Roths., *Nov. Zool.*, XIV, p. 329 (1907).

This genus contains a single species found on bats in South Africa.

1. **Thaumapsylla breviceps** Rothschild.

   Thaumapsylla breviceps Roths., *Nov. Zool.*, XIV, p. 329 (1907).

   Described from specimens taken off Cape fruit bat, *Roussetus leachi (= R. collaris)* in the Cape Province, and off long-winged fruit bat, *Eidolon helvum (= Roussetus stramineus)* at Knysna, Cape Province.

Genus Ischnopsyllus Westwood.

Ischnopsyllus Westwood, *Ent. Mo. Mag.*, I, p. 359 (1833).

This genus is widely distributed and contains twenty-six species found on bats.

Genotype: *Ceratopsyllus elongatus* Curtis.

1. **Ischnopsyllus ashworthii** Waterston.

   Ischnopsyllus ashworthii Waterst., *Proc. R. Physic. Soc. Edin.*, XIX, i, p. 12, fig. (1913).

   Described from a single female taken off Namaqua augur bat, *Rhinolophus geoffroyii augur (= R. augur)* at Pirie, Kingwilliamstown, Cape Province.

2. **Ischnopsyllus emminus** Jordan and Rothschild.

   Ischnopsyllus emminus Jord. & Roths., *Ectoparasites*, I, iii, p. 142, f. 116, 117 (1921).

   Described from one ♂ and two ♀♀ taken off Cape house bat, *Eptesicus capensis (= Vespertilio capensis)* at Greenwood Park, Natal.

3. **Ischnopsyllus grahami** Waterston.

Ischnopsyllus grahami Waterst., *Rec. Albany Mus.*, III, ii, p. 115, f. 1-3 (1915).

Described from ♂ taken off *Eptesicus capensis* (Cape house bat) at Grahamstown, Cape Province.

4. **Ischnopsyllus isomalus** Waterston.

Ischnopsyllus isomalus Waterst., *Rec. Albany Mus.*, III ii, p. 109, f. 4, 5 (1915).

Araeopsylla isomalus (Waters.) Jord. and Roths., *Ectoparasites*, I, iii, p. 146 (1921).

Described from one ♀ taken in a cave near Pretoria, in which two species of bats were present, namely *Miniopterus sp.* and Namaqua augur bat, *Rhinolophus geoffroyii augur* (= *R. augur*). Specimens have been taken off *Miniopterus natalensis* (Natal sociable bat) in a cave at Irene, near Pretoria, 25th October, 1931 (coll. G.A.H.B.).

Genus Araeopsylla Jordan and Rothschild.

Araeopsylla Jord. & Roths., *Ectoparasites*, I, iii, p. 146 (1921).

This genus contains three species, one of which has been found in South Africa.

Genotype: *Ischnopsyllus scitulus* Rothschild.

1. **Araeopsylla scitulus** (Rothschild), Fig. 26L.

Ischnopsyllus scitulus Roths., *Nov. Zool.*, XVI, p. 55 (1909).

Described from specimens taken off *Nyctinomus aegyptiacus* (Egyptian free-tailed bat) at Kingwilliamstown, Cape Province. We have also taken specimens off *Nyctinomus bocagei* (Bocage's free-tailed bat) at Onderstepoort (det. Dr. K. Jordan).

Genus Rhinolophopsylla Oudemans.

Rhinolophopsylla Oudemans, *Ent. Bericht.*, III, p. 3 (1909).

This genus contains four species found in Europe, Asia and Africa.

Genotype: *Typhlopsylla unipectinata* Taschenb.

1. **Rhinolophopsylla capensis** Jordan and Rothschild.

Rhinolophopsylla capensis Jord. & Roths., *Ectoparasites*, I, iii, p. 148, f. 126-128 (1921).

Described from a small series of ♂♂ and ♀♀ taken off *Nycteris capensis* (Cape long-eared bat) at Mfongosi, Zululand. Specimens taken off *Rhinolophus geoffroyii augur*, *Myotis tricolor* and *Miniopterus natalensis* in a cave at Irene, near Pretoria, 25th October, 1931 (coll. G.A.H.B.).

HOST-LISTS.

The host-lists have been divided into five parts as follows:—

It was thought advisable to arrange the mammals and birds according to the latest check-lists of the mammals and birds of South Africa. The classification and arrangement of the mammals, therefore, is that adopted by Austin Roberts in his M.S. " A Synoptic Check-list of the Mammals of South Africa ", which will probably be published in the *Annals of the Transvaal Museum*, and the birds have been arranged according to " Synoptic Check-list of the Birds of South Africa " by the same author.

The families and specific names of the birds have been numbered, the numbers corresponding to the numbers in the above check-list.

The letters between brackets before the specific names of the parasites refer to the orders and families to which they belong, the following being a list:—

(A.S.)	=	Acarina.......	Family	Sarcoptidae (mange and scab mites).
(A.C.)	=		,,	Cytoleichidae.
(A.A.)	=		,,	Analgesidae (feather mites).
(A.D.)	=		,,	Demodicidae (sebacic mites).
(A.C.²)	=		,,	Cheyletidae.
(A.T.)	=		,,	Trombidiidae (harvest mites).
(A.D.²)	=		,,	Dermanyssidae.
(A.P.)	=		,,	Parasitidae.
(I.A.)	=		,,	Argasidae (ticks).
(I.I.)	=		,,	Ixodidae (ticks).
(D.)	=	Dermaptera..	,,	Hemimeridae.
(M.)	=	Anoplura.....	Suborder	Mallophaga (biting lice).
(R.)	=		,,	Rhyncophthirina (elephant lice).
(S.)	=		,,	Siphunculata (sucking lice).
(H.C.)	=	Hemiptera...	Family	Cimicidae (parasitic bugs).
(D.H.)	=	Diptera	,,	Hippoboscidae.
(D.S.)	=		,,	Streblidae.
(D.N.)	=		,,	Nycteribiidae.
(S.T.)	=	Siphonaptera	,,	Tungidae (chigoes).
(S.P.)	=		,,	Pulicidae (true fleas).
(S.I.)	=		,,	Ischnopsyllidae (bat fleas).

I.—HOST-LIST OF THE ECTOPARASITES FOUND ON MAN AND DOMESTIC ANIMALS IN SOUTH AFRICA.

HOMO SAPIENS.

(A.S.) *Sarcoptes scabiei.*—A number of cases of human beings becoming infected with the varieties *scabiei*, *canis*, *bubulus* and *equi* have been recorded in Europe, and in addition to these the varieties *suis* and *caprae* have also been transmitted to man.

(A.D.) *Demodex folliculorum* G. Simon, is another acarus which probably occurs in man in South Africa, but has not yet been recorded.

(A.D.[2]) *Dermanyssus gallinae* Dugès.
(A.D.[2]) *Liponyssus bacoti* (Hirst).
(I.A.) *Argas mégnini* Dugès.
(I.A.) *Argas moubata* Murray.
(I.A.) *Argas pavimentosus* (Neu.).
(I.A.) *Argas persicus* (Oken).
(I.A.) *Argas savignyi* Aud.
(I.A.) *Argas talaje capensis* (Neu.).
(I.A.) *Argas vespertilionis* (Latr.).
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus maculatus* Neu.
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch. (Larvae).
(S.) *Pediculus humanus race humanus* Linné.
(S.) *Pediculus humanus race corporis* De Geer.
(S.) *Phthirus pubis* (Linné).
(R.C.) *Cimex lectularius* Linné.
(S.T.) *Tunga penetrans* (Linné).
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Pulex irritans* Linné.
(S.P.) *Xenopsylla cheopis* (Roths.).
(S.P.) *Ceratophyllus fasciatus* (Bosc.).
(S.P.) *Leptopsylla segnis* (Schönh.).

EQUUS CABALLUS.

(A.S.) *Sarcoptes scabiei equi* Raspail.
(A.S.) *Sarcoptes scabiei bubulus* (Oudemans).
(A.S.) *Sarcoptes scabiei caprae.* Fürstenb.
(A.S.) *Psoroptes equi* (Hering).
(A.T.) *Trombicula sp.*
(I.A.) *Argas mégnini* Dugès.
(I.A.) *Argas moubata* Murray.
(I.A.) *Argas savignyi* Aud.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus capensis* Koch.

(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus evertsi mimeticus* Dönitz.
(I.I.) *Rhipicephalus lunulatus* Neu.
(I.I.) *Rhipicephalus oculatus* Neu.
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Margaropus winthemi* Karsch.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Boophilus microplus* (Canestr.).
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(I.I.) *Amblyomma variegatum* (Fabr.).
(M.) *Bovicola equi* (Linné).
(S.) *Haematopinus asini* (Linné).
(D.H.) *Hippobosca rufipes* Von Olfers.
(D.H.) *Hippobosca maculata* Leach.
(S.T.) *Echidnophaga larina* Jord. & Rothsch.

Equus asinus.

(A.S.) *Sarcoptes scabiei equi* Raspail.
(I.A.) *Argas mégnini* Dugès.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Margaropus winthemi* Karsch.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(M.) *Bovicola equi* (Linné).
(S.) *Haematopinus asini* (Linné).
(D.H.) *Hippobosca rufipes* Von Olfers.

Mule.

(I.A.) *Argas mégnini* Dugès.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Margaropus winthemi* Karsch.
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(I.I.) *Amblyomma variegatum* (Fabr.).
(M.) *Bovicola equi* (Linné).
(S.) *Haematopinus asini* (Linné).
(D.H.) *Hippobosca rufipes* Von Olfers.

Cattle.

(A.S.) *Sarcoptes scabiei bubulus* (Oudemans).
(A.S.) *Sarcoptes scabiei caprae* Fürstenb.
(A.S.) *Sarcoptes scabiei equi* Raspail.
(A.S.) *Sarcoptes scabiei mégnini nov. nom.*
(A.S.) *Sarcoptes scabiei suis* Gerlach.
(A.S.) *Psoroptes bovis* (Gerlach).
(A.S.) *Psoroptes natalensis* Hirst.

(A.T.) *Trombicula sp.*
(I.A.) *Argas mégnini* Dugès.
(I.A.) *Argas moubata* Murray.
(I.A.) *Argas savignyi* Aud.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Haemaphysalis silacea* Robinson.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus capensis* Koch.
(I.I.) *Rhipicephalus duttoni* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus evertsi mimeticus* Dönitz.
(I.I.) *Rhipicephalus lunulatus* Neu.
(I.I.) *Rhipicephalus oculatus* Neu.
(I.I.) *Rhipicephalus sanguineus* (Latr.).
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Margaropus winthemi* Karsch.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Boophilus microplus* (Canestr.).
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(I.I.) *Amblyomma variegatum* (Fabr.).
(I.I.) *Amblyomma marmoreum* Koch.
(M.) *Bovicola bovis* (Linné).
(S.) *Haematopinus eurysternus* (Nitzsch).
(S.) *Linognathus vituli* (Linné).
(D.H.) *Hippobosca rufipes* Von Olfers.
(D.H.) *Hippobosca maculata* Leach.
(S.T.) *Echidnophaga larina* Jord. & Rothsch.

Sheep.

(A.S.) *Sarcoptes scabiei bubulus* (Oudemans).
(A.S.) *Sarcoptes scabiei caprae* Fürstenb.
(A.S.) *Sarcoptes scabiei mégnini nov. nom.*
(A.S.) *Psoroptes ovis* (Hering).
(A.T.) *Trombicula sp.*
(I.A.) *Argas mégnini* Dugès.
(I.A.) *Argas moubata* Murray.
(I.A.) *Argas savignyi* Aud.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus punctatus* Bedford.
(I.I.) *Rhipicephalus oculatus* Neu.
(I.I.) *Rhipicephalus sanguineus* (Latr.).
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.

(I.I.) *Amblyomma variegatum* (Fabr.).
(M.) *Boricola ovis* (Linné).
(S.) *Linognathus africanus* Kellogg & Paine.
(S.) *Linognathus pedalis* (Osborn).
(D.H.) *Melophagus ovinus* Linné.

FAT-TAILED SHEEP.

(M.) *Boricola peregrina* (Tasch.).

GOATS.

(A.S.) *Sarcoptes scabiei caprae* Fürstenb.
(A.S.) *Sarcoptes scabiei equi* Raspail.
(A.S.) *Sarcoptes scabiei mégnini nov. nom.*
(A.S.) *Psoroptes caprae.*
(A.S.) *Chorioptes caprae* Gerv. & Bened.
(A.D.) *Demodex caprae* Railliet.
(I.A.) *Argas mégnini* Dugès.
(I.A.) *Argus moubata* Murray.
(I.A.) *Argas savignyi* Aud.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus capensis* Koch.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus oculatus* Neu.
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(I.I.) *Amblyomma variegatum* (Fabr.).
(I.I.) *Amblyomma marmoreum* Koch (larve and nymphs).
(M.) *Boricola caprae* (Gurlt).
(M.) *Boricola limbatus* (Gervais).
(M.) *Boricola painei* (Kellegg & Nakayama).
(S.) *Linognathus africanus* Kellogg & Paine.
(S.) *Linognathus stenopsis* (Burm.).

PIG.

(A.S.) *Sarcoptes scabiei bubulus* (Oudemans).
(A.S.) *Sarcoptes scabiei caprae* Fürstenb.
(A.S.) *Sarcoptes scabiei suis* Gerlach.
(A.D.) *Demodex phylloides* Csokor.
(I.A.) *Argas savignyi* Aud.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(S.) *Haematopinus suis* (Linné).
(S.T.) *Echidnophaga larina* Jord. & Rothsch.

DOG.

(A.D.) *Demodex canis* Leyd.
(I.A.) *Argas mégnini* Dugès.
(I.A.) *Argas moubata* Murray.

(I.A.) *Argas savignyi* Aud.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Rhipicentor nuttalli* Cooper & Robins.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus capensis* Koch.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus lunulatus* Neu.
(I.I.) *Rhipicephalus sanguineus* (Latr.).
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(I.I.) *Amblyomma variegatum* (Fabr.).
(M.) *Heterodoxus longitarsus* (Piaget).
(S.) *Linognathus setosus* (Olfers).
(D.H.) *Hippobosca capensis* Von Olfers.
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.T.) *Echnidnophaga larina* Jord. & Rothsch.
(S.P.) *Pulex irritans* Linné.
(S.P.) *Ctenocephalides canis* (Curtis).
(S.P.) *Ctenocephalides felis* (Bouché).

CAT.

(A.S.) *Notoedres cati cati* (Hering).
(I.A.) *Argas mégnini* Dugès.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Rhipicephalus sanguineus* (Latr.).
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Hyalomma aegyptium impressum* Koch.
(M.) *Felicola subrostrata* (Nitzsch).
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Xenopsylla brasiliensis* (Baker).
(S.P.) *Xenopsylla cheopis* (Rothsch.).
(S.P.) *Ctenocephalides felis* (Bouché).

RABBIT.

(A.S.) *Sarcoptes scabiei precox* Canest.
(A.S.) *Notoedres cati cuniculi* (Gerlach).
(A.S.) *Psoroptes cuniculi* (Delafond).
(A.C.[2]) *Cheyletiella parasitivorax* Mégnini.
(S.) *Haemodipsus ventricosus* (Denny).

GUINEA-PIG.

(M.) *Gyropus ovalis* Nitzsch.
(M.) *Gliricola porcelli* (Linné).

II.—HOST-LIST OF THE ECTOPARASITES FOUND ON DOMESTIC BIRDS IN SOUTH AFRICA.

Fowl.

(A.S.) *Cnemidocoptes mutans* (Robin).
(A.S.) *Cnemidocoptes gallinae* (Railliet).
(A.C.) *Cytoleichus nudus* (Viz.).
(A.A.) *Dermoglyphus elongatus* (Mégn.).
(A.A.) *Dermoglyphus minor* (Nörn.).
(A.A.) *Epidermoptes bilobatus* Riv.
(A.A.) *Rivoltasia bifurcata* (Riv.).
(A.C.?) *Syringophilus bipectinatus* Heller.
(A.D.?) *Liponyssus bursa* Berlese.
(I.A.) *Argas moubata* Murray.
(I.A.) *Argas pavimentosus* (Neu.).
(I.A.) *Argas persicus* (Oken).
(I.A.) *Argas savignyi* Aud.
(I.A.) *Argas talaje capensis* (Neu.).
(I.I.) *Hyalomma aegyptium impressum* Koch (larvae and nymphs).
(I.I.) *Amblyomma hebraeum* Koch (larvae and nymhps).
(M.) *Lipeurus caponis* (Linné).
(M.) *Lipeurus heterographus* Nitzsch.
(M.) *Lipeurus tropicalis* Peters.
(M.) *Goniodes dissimilis* Nitzsch.
(M.) *Goniocotes hologaster* Nitzsch.
(M.) *Goniocotes gigas* Taschb.
(M.) *Menopon gallinae* (Linné).
(M.) *Neumannia numidae* (Giebel).
(M.) *Eomenacanthus stramineus* (Nitzsch).
(H.C.) *Cimex columbarius* Jenyns.
(S.T.) *Echidnophaga gallinacea* (Westw.).

Turkey.

(A.S.) *Cnemidocoptes mutans* (Robin.).
(A.A.) *Microspalax chanayi* Trt.
(A.A.) *Dermoglyphus minor* (Nörn.).
(A.A.) *Mégninia cubitalis* (Mégn.).
(I.A.) *Argas persicus* (Oken).
(I.I.) *Hyalomma aegyptium impressum* Koch (nymphs).
(M.) *Lipeurus gallipavonis* (Geoff.).
(M.) *Goniodes meleagridis* (Linné).
(M.) *Eomenacanthus stramineus* (Nitzsch).

Goose.

(I.A.) *Argas persicus* (Oken).
(M.) *Esthiopterum anseris* (Linné).

Duck.

(I.A.) *Argas persicus* (Oken).
(M.) *Menopon tumidum* Piaget.
(M.) *Anatoecus icterodes* (Nitzsch).

PIGEON.
- (A.A.) *Falculifer rostratus* (Buchh.).
- (A.A.) *Mégninia columbae* (Buchh.).
- (A.A.) *Analges bifidus* (Nitzsch).
- (A.A.) *Pterophagus strictus* Mégn.
- (A.C.[2]) *Syringophilus columbae* Hirst.
- (A.C.[2]) *Sarcopterinus nidulans* (Nitzsch).
- (I.A.) *Argas persicus* (Oken).
- (M.) *Goniocotes bidentatus* (Scopoli).
- (M.) *Menacanthus giganteus* (Denny).
- (D.H.) *Pseudolynchia maura* (Bigot).

CANARY.
- (I.A.) *Argas persicus* (Oken).
- (M.) *Menacanthus spiniferus* (Piaget).

PEACOCK.
- (A.A.) *Pterolichus paronis* Oudms.
- (A.A.) *Mégninia pavonis* Oudms.
- (A.C.[2]) *Cheletoides uncinata* (Heller).
- (M.) *Goniodes parviceps* Piaget.
- (M.) *Goniodes pavonis* (Linné).
- (M.) *Goniocotes rectangulatus* N.
- (M.) *Menopon phaeostomum* N.

OSTRICH.
- (A.A.) *Pterolichus bicaudatus* (Gerv.).
- (A.A.) *Pterolichus sculpturatus* Hirst.
- (I.A.) *Argas mégnini* Dugès.
- (I.A.) *Argas persicus* (Oken).
- (I.I.) *Hyalomma aegyptium impressum* Koch.
- (I.I.) *Amblyomma hebraeum* Koch.
- (M.) *Struthiolipeurus struthionis* (Ger.).
- (D.H.) *Hippobosca struthionis* Janson.

III.—HOST-LIST OF THE ECTOPARASITES FOUND ON SOUTH AFRICAN MAMMALIA.

Order INSECTIVORA.

Family CHRYSOCHLORIDAE.

No parasites have been recorded from the South African golden moles.

Family ERINACEIDAE.

Atelerix frontalis (A. Smith). South African hedgehog.
- (I.I.) *Ixodes pilosus* Koch.
- (I.I.) *Haemaphysalis leachii* (Aud.).
- (I.I.) *Rhipicentor nuttalli* Cooper & Robins.
- (I.I.) *Rhipicephalus lunulatus* Neu.
- (I.I.) *Rhipicephalus sanguineus* (Latr.).
- (I.I.) *Rhipicephalus simus* Koch.
- (I.I.) *Rhipicephalus theileri* Bedf. & Hewitt.
- (I.I.) *Hyalomma aegyptium impressum* Koch. (Larvae and nymphs).
- (S.T.) *Echidnophaga larina* Jord. & Roths.
- (S.P.) *Ctenocephalides connatus* (Jordan).

Family CROCIDURIDAE.

Myosorex tenuis Thos. & Schw. Drakensberg forest shrew.
(S.P.) *Listropsylla chelura* Rothsch.

Crocidura flavescens I. Geoff. Red shrew.
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Dinopsyllus ellobius* Rothsch.

Family MACROSCELIDIDAE.

Macroscelides proboscideus (Shaw). Karroo elephant shrew.
(S.P.) *Hypsophthalmus granti* Rothsch.

Elephantulus myurus jamesoni Chubb. Jameson's rock-shrew.
(S.) *Neolinognathus elephantuli* Bedford.

Order CARNIVORA.

Family VIVERRIDAE.

Subfamily VIVERRINAE.

Civettictis civetta orientalis (Matschie). Civet cat.
(I.I.) *Haemaphysalis leachii* (Aud.).

Genetta felina felina (Thumb.). Cape small-spotted genet.
(I.I.) *Haemaphysalis leachii* (Aud.).

Genetta felina ludia Thos. and Schw. Transvaal small-spotted genet.
(I.I.) *Haemaphysalis leachii* (Aud.).
(M.) *Felicola genetta* (Bedford).

Genetta tigrina Schreb. Large-spotted genet.
(I.I.) *Haemaphysalis leachii* (Aud.).
(M.) *Felicola genetta* (Bedford).
(S.P.) *Ctenocephalides felis strongylus* Jordan.

Genetta rubiginosa Puch. Rusty-spotted genet.
(S.P.) *Ctenocephalides connatus* (Jord.).

Subfamily HERPESTINAE.

Herpestes caffer (Gmel.). Large grey mongoose.
(I.I.) *Ixodes rasus* Neu.
(M.) *Felicola rammei* (Stobbe).

Myonax nigratus (Thomas). Damara brown mongoose.
(M.) *Felicola calogalea* (Bedford).

Myonax ratlamuchi (A. Smith). (*Herpestes badius.*) Ruddy mongoose.
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Ctenocephalides connatus* (Jord.).
(S.P.) *Listropsylla vicinus* (Rothsch.).

Myonax cauui (A. Smith). Slender mongoose.
- (I.I.) *Ixodes rasus* Neu.
- (I.I.) *Haemaphysalis leachii* (Aud.).
- (I.I.) *Rhipicephalus simus* Koch.
- (M.) *Felicola calogalea* (Bedford).
- (S.P.) *Chiastopsylla rossi* (Waterst.).
- (S.P.) *Listropsylla agrippinae* (Rothsch.).

Myonax pulverulentus (Wagner). Grey mongoose.
- (M.) *Felicola calogalea* (Bedford).
- (S.T.) *Echidnophaga larina* Jord. & Rothsch.
- (S.P.) *Ctenocephalides felis strongylus* (Jord.).

Ichneumia albicauda (G. Cuv.). White-tailed mongoose.
- (M.) *Felicola rostrata* Bedford.

Cynictis penicillata (G. Cuv.). Yellow mongoose.
- (I.I.) *Haemaphysalis leachii* (Aud.).
- (M.) *Felicola cynictis* (Bedford).
- (S.T.) *Echidnophaga bradyta* Jord. & Rothsch.
- (S.T.) *Echidnophaga gallinacea* (Westw.).
- (S.P.) *Xenopsylla eridos* (Rothsch.).
- (S.P.) *Xenopsylla erilli* (Rothsch.).
- (S.P.) *Ctenocephalides connatus* (Jord.).
- (S.P.) *Chiastopsylla rossi* (Waterst.).
- (S.P.) *Listropsylla dorippae* (Rothsch.).

Paracynictis selousi (de Winton). Selous' mongoose.
- (M.) *Felicola setosa* Bedford.

Atilax paludinosus (G. Cuv.). Water mongoose.
(Syn. *Herpestes galera*).
- (M.) *Felicola acutirostris* (Stobbe).

Helogale parvula brunnula Thos. and Schw. Letaba pigmy mongoose.
- (M.) *Felicola helogale* Bedford.

Mungos mungo (Gmel). Banded mongoose.
- (I.I.) *Amblyomma hebraeum* Koch. (Nymphs).
- (S.T.) *Echidnophaga gallinacea* (Westw.).

Suricata suricatta Erxl. (*S. tetradactyla*). Suricate.
- (I.I.) *Haemaphysalis leachii* (Aud.).
- (M.) *Suricatoecus cooleyi* (Bedford).
- (S.T.) *Echidnophaga bradyta* Jord. & Rothsch.
- (S.T.) *Echidnophaga gallinacea* (Westw.).
- (S.P.) *Xenopsylla eridos* (Rothsch.).
- (S.P.) *Xenopsylla erilli* (Rothsch.).
- (S.P.) *Ctenocephalides connatus* (Jord.).
- (S.P.) *Chiastopsylla rossi* (Waterst.).

Family HYAENIDAE.

Crocuta crocuta Matschie. Spotted hyaena.
- (S.T.) *Echidnophaga larina* Jord. & Rothsch.

Hyaena.
- (I.I.) *Rhipicephalus simus* Koch.

Family PROTELIDAE.

Proteles cristatus (Sparrm.). Aardwolf.

(I.I.) *Haemaphysalis leachii* (Aud.).
(M.) *Protelicola intermedia* Bedford.
(S.T.) *Echidnophaga larina* Jord. & Rothsch.
(S.P.) *Pulex irritans* Linné.

Family FELIDAE.

Leo leo Linné. Lion.

(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Rhipicephalus sanguineus* (Latr.)
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Amblyomma hebraeum* Koch.

Caracal caracal (Schreb.). Caracal.

(S.P.) *Pulex irritans* Linné.
(S.P.) *Procaviopsylla creusae* (Rothsch.). Straggler.
(S.P.) *Procaviopsylla divergens* (Jord. & Roths.). Straggler.

Micropelis nigripes (Burch.). Black-footed cat.

(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Amblyomma hebraeum* Koch. (Larvae).

Felis ocreata caffra (Desm.). Cape wild cat.

(I.I.) *Ixodes pilosus* Koch.
(M.) *Felicola caffra* (Bedford).
(S.T.) *Echidnophaga larina* Jord. & Rothsch.
(S.P.) *Ctenocephalides connatus* (Jordan).
(S.P.) *Ctenocephalides felis* (Bouché).

Panthera pardus. Leopard.

(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Haemaphysalis leachii* (Aud.).
(S.T.) *Echidnophaga larina* Jord. & Rothsch.

Family CANIDAE.

Vulpes chama (A. Smith). Silver fox.

(A.S.) *Sarcoptes scabiei* var.
(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Rhipicephalus theileri* Bedford & Hewitt.
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.T.) *Echidnophaga larina* Jord. & Roths.
(S.P.) *Synosternus caffer* (Roth. & Jord.).
(S.P.) *Ctenocephalides connatus* (Jordan).

Thos mesomelas (Schreb.). Black-backed jackal.

(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Pulex irritans* Linné.
(S.P.) *Synosternus caffer* (Jord. & Rothsch.). Straggler.
(S.P.) *Ctenocephalides connatus* (Jordan).

Lycaon pictus venaticus Burch. Cape hunting dog.
- (I.I.) *Rhipicephalus appendiculatus* Neu.
- (I.I.) *Rhipicephalus simus* Koch.
- (I.I.) *Amblyomma hebraeum* Koch.
- (S.T.) *Echidnophaga larina* Jord. & Rothsch.
- (S.P.) *Ctenocephalides connatus* (Jordan).

Family MUSTELIDAE.

Subfamily LUTRINAE.

No parasites have been recorded from South African otters.

Subfamily MELINAE.

Mellivora capensis (Schreb.). Cape badger.
- (I.I.) *Haemaphysalis leachii* (Aud.).
- (M.) *Trichodectes rosseleri* Stobbe.

Subfamily MEPHITINAE.

Ictonyx striatus (Parry). Stink muishond.
- (I.I.) *Haemaphysalis leachii* (Aud.).
- (M.) *Trichodectes oralis* Bedford.
- (S.T.) *Echidnophaga bradyta* Jord. & Rothsch.
- (S.P.) *Xenopsylla erilli* (Rothsch.).
- (S.P.) *Ctenocephalides connatus* (Jord.).

Poecilogale albinucha (Gray). Snake muishond.
- (M.) *Trichodectes oralis* Bedford.

Family PHOCIDAE.

Macrorhinus leoninus. Elephant seal.
- (S.) *Lepidophthirus macrorhini* Enderl.

Order ARTIODACTYLA.

Family HIPPOPOTAMIDAE.

Hippopotamus amphibius Linné. Hippopotamus.
- (I.I.) *Hyalomma hippopotamense* (Denny).

Family SUIDAE.

Koiropotamus choeropotamus choeropotamus (Desm.). Bush pig.
- (I.I.) *Rhipicephalus simus* Koch.
- (I.I.) *Hyalomma aegyptium* (Linné).
- (S.) *Haematopinus latus* Neumann.

Phacochoerus aethiopicus (Linné). African warthog.
- (I.I.) *Hyalomma aegyptium* (Linné).
- (S.) *Haematopinus phacochoeri* Enderlein.

Phacochoerus sundevalli (Lönnb.) Natal warthog.
- (I.I.) *Rhipicephalus maculatus* Neu.
- (I.I.) *Rhipicephalus simus* Koch.
- (I.I.) *Amblyomma hebraeum* Koch.
- (S.) *Haematopinus phacochoeri* Enderlein.
- (S.T.) *Echidnophaga larina* Jord. & Roths.

Family GIRAFFIDAE.

Giraffa camelopardalis L. Giraffe.

(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Amblyomma hebraeum* Koch.
(S.) *Linognathus brevicornis* (Giebel).

Family BOVIDAE.

Syncerus caffer (Sparrm.). African buffalo.

(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus maculatus* Neu.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Amblyomma hebraeum* Koch.
(S.) *Haematopinus bufali* (De Geer).

Gorgon taurinus (Burch.). Blue wildebeest.

(A.S.) *Sarcoptes scabiei var.*
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Hyalomma aegyptium* (Linné).
(I.I.) *Amblyomma hebraeum* Koch.
(S.) *Linognathus gnu* Bedford.
(S.) *Linognathus nov. sp.*
(M.) *Damalinia theileri* Bedford.
(D.H.) *Hippobosca rufipes* Von Olfers.

Connochaetes gnu (Zimm.). Black wildebeest.

(S.) *Linognathus gnu* Bedford.
(M.) *Bovicola harrisoni* (Cumm.).

Damaliscus albifrons (Burch). Blesbok.

(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Boophilus decoloratus* (Koch).
(M.) *Damalinia crenelata* (Piaget).
(S.) *Linognathus nov. sp.*

Damaliscus dorcas (Pallas). [*D. pygargus* (Pall.)]. Bontebok.

(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(M.) *Damalinia crenelata* (Piaget).
(S.P.) *Xenopsylla cheopis* (Rothsch.).

Equinus equinus (Desm.). Roan antelope.

(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Hyalomma aegyptium* (Linné).

Ozanna nigra (Harris). Sable antelope.

(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Boophilus decoloratus* (Koch).
(S.) *Linognathus nov. sp.*

Kobus ellipsiprymnus ellipsiprymnus (Ogilby). Waterbuck.

(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus sanguineus* (Latr.).
(I.I.) *Boophilus decoloratus* (Koch).

Redunca arundinum (Bodd.). Reedbuck.
- (I.I.) *Haemaphysalis aciculifer* Warburton.
- (I.I.) *Rhipicephalus evertsi* Neu.
- (I.I.) *Hyalomma aegyptium* (Linné).
- (S.) *Linognathus fahrenholzi* Paine.
- (M.) *Tricholipeurus reduncae* Bedford.
- (D.H.) *Echestypus paradoxus* (Newst.).

Redunca fulvorufula (Afz.). Mountain reedbuck.
- (S.) *Linognathus fahrenholzi* Paine.
- (M.) *Tricholipeurus trabeculae* Bedford.

Pelea capreolus (Bchst.). Vaal rhebok.
- (I.I.) *Ixodes rubicundus* Neu.

Antidorcas marsupialis (Zimm.). Springbok.
- (I.I.) *Rhipicephalus evertsi* Neu.
- (S.) *Linognathus tibialis* (Piaget).
- (S.) *Linognathus nov. sp.*
- (M.) *Tricholipeurus antidorcus* Bedford.
- (D.H.) *Echestypus binoculus* Speiser.

Aepyceros melampus (Lcht.). Impala.
- (I.I.) *Ixodes rasus* Neu.
- (I.I.) *Rhipicephalus appendiculatus* Neu.
- (I.I.) *Rhipicephalus evertsi* Neu.
- (I.I.) *Rhipicephalus oculatus* Neu.
- (I.I.) *Boophilus decoloratus* (Koch).
- (S.) *Linognathus sp.*
- (M.) *Tricholipeurus nov. sp.*

Aepyceros petersi Bochee. Angola impala.
- (M.) *Tricholipeurus aepycerus* Bedford.

Raphiceros campestris (Thunb.). Steenbuck.
- (A.S.) *Sarcoptes scabiei* var.
- (I.I.) *Ixodes rubicundus* Neu.
- (I.I.) *Rhipicephalus evertsi* Neu.
- (S.) *Linognathus sp.*
- (M.) *Tricholipeurus lineatus* (Bedford).
- (D.H.) *Echestypus binoculus* Speiser.

Nototragus melanotis (Thunberg). Grysbok.
- (I.I.) *Ixodes pilosus* Koch.
- (I.I.) *Ixodes rubicundus* Neu.
- (I.I.) *Rhipicephalus evertsi* Neu.

Taurotragus oryx (Pallas). Eland.
- (I.I.) *Rhipicephalus evertsi* Neu.
- (I.I.) *Rhipicephalus evertsi mimeticus* Dönitz.
- (I.I.) *Rhipicephalus oculatus* Neu.
- (I.I.) *Hyalomma aegyptium* (Linné).
- (S.) *Haematopinus taurotragi* Cumm.
- (S.) *Linognathus taurotragus* Bedford.

Strepsiceros strepsiceros (Pallas). Koodoo.

(A.S.) *Sarcoptes scabiei strepsiceros* Bedford.
(I.I.) *Rhipicentor nuttalli* Cooper & Robins.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus evertsi mimeticus* Dönitz.
(I.I.) *Rhipicephalus oculatus* Neu.
(I.I.) *Rhipicephalus maculatus* Neu.
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Amblyomma hebraeum* Koch.
(S.) *Haematopinus taurotragi* Cumm.
(D.H.) *Echestypus paradoxus* (Newst.).

Nyala angasi (Ang.). Nyala.

(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus* sp.
(I.I.) *Amblyomma hebraeum* Koch.
(D.H.) *Echestypus paradoxus* (Newst.).

Tragelaphus sylvaticus (Sparrm.). Bushbuck.

(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Haemaphysalis parmata* Neu.
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Amblyomma hebraeum* Koch.
(S.) *Linognathus nov. sp.*
(S.) *Linognathus nov. sp.*
(D.H.) *Echestypus paradoxus* (Newst.).

Sylvicapra grimmi (Linné). Cape duiker.

(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus maculatus* Neu.
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Hyalomma aegyptium impressum* Koch.
(I.I.) *Amblyomma hebraeum* Koch.
(M.) *Tricholipeurus lerouxi* Bedford.
(S.) *Linognathus angulatus* (Piaget).
(D.H.) *Echestypus paradoxus* (Newst.).
(S.P.) *Ctenocephalides connatus* (Jord.)

Cephalophus natalensis (A. Smith). Red duiker.

(S.) *Linognathus angulatus* (Piaget).

Philantomba monticola (Thunb.). Blue duiker.

(M.) *Tricholipeurus bedfordi* (Hill).
(S.) *Linognathus angulatus* (Piaget).
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Ctenocephalides canis* (Curtis).
(S.P.) *Ctenocephalides felis* (Bouché).

Order PROBOSCIDEA.

Family ELEPHANTIDAE.

Loxodonta africanus (L.). African elephant.

(I.I.) *Amblyomma hebraeum* Koch.
(R.) *Haematomyzus elephantis* Piaget.

Order HYRACOIDEA.

Family PROCAVIIDAE.

Dendrohyrax arborea (A. Smith). Bush dassie.

(M.) *Procavicola univirgata* (Neu.).
(M.) *Procavicola neumanni* (Stobbe).
(M.) *Procaviphilus granulatus* (Ferris).

Herterohyrax granti (Wroughton). Grant's dassie.

(M.) *Procavicola lindfieldi* (Hill).
(M.) *Procavicola heterohyracis* Bedford.
(M.) *Dasyonyx transvaalensis* Bedford.
(M.) *Procaviphilus sclerotis* Bedford.

Heterohyrax ruddi (Wroughton). Rudd's dassie.

(M.) *Procavicola lindfieldi* (Hill).
(M.) *Procavicola emarginata* (Bedford).
(M.) *Dasyonyx oculatus* (Bedford).
(M.) *Procaviphilus robertsi* (Bedford).
(S.) *Prolinognathus caviae-capensis* (Pallas).

Procavia waterbergensis Brauer. Loc. South-West Africa.

(M.) *Dasyonyx waterbergensis* Bedford.
(S.) *Prolinognathus caviae-capensis* (Pallas).

Procavia coombsi Roberts. Loc. Transvaal, Orange Free State.

(I.I.) *Haemaphysalis cooleyi* Bedford.
(I.I.) *Rhipicephalus punctatus* Bedford.
(M.) *Procavicola pretoriensis* Bedford.
(M.) *Dasyonyx ovalis* Bedford.
(M.) *Dasyonyx transvaalensis* Bedford.
(M.) *Procaviphilus serraticus* (Hill).?
(S.) *Prolinognathus caviae-capensis* (Pallas).
(S.P.) *Procaviopsylla angolensis* Jordan.

Procavia capensis (Pallas). Loc. Capetown, C.P.

(S.P.) *Procaviopsylla creusae* (Rothsch.).
(S.) *Prolinognathus caviae-capensis* (Pallas).

Procavia natalensis Roberts. Loc. Pigg's Peak, Swaziland; Deepdale, Natal; Grahamstown and Knysna, Cape Province.

(M.) *Procavicola lindfieldi* (Hill).
(M.) *Procavicola natalensis* Bedford.
(M.) *Procaviphilus serraticus* (Hill).
(S.P.) *Procaviopsylla creusae* (Rothsch.).

Procavia sp. Loc. Mtabamhlope, Natal.
- (I.I.) *Ixodes rasus* Neumann.
- (M.) *Procavicola lindfieldi* (Hill).
- (M.) *Procavicola sternata* (Bedford).
- (M.) *Procaviphilus serraticus* (Hill).
- (S.) *Prolinognathus caviae-capensis* (Pallas).
- (S.P.) *Procaviopsylla divergens* (Jord. & Rothsch.).

Procavia sp. Loc. Mount Fletcher, C.P.
- (M.) *Procavicola subparva* Bedford.

Procavia sp. Loc. Lamberts Bay, C.P.
- (M.) *Procavicola parva* Bedford.
- (M.) *Procaviphilus serraticus* (Hill).
- (S.) *Prolinognathus caviae-capensis* (Pallas).

Procavia sp. Loc. Deelfontein, C.P.
- (S.P.) *Procaviopsylla creusae* (Rothsch.).
- (S.P.) *Procaviopsylla divergens* (Jord. & Rothsch.).

Order PERISSODACTYLA.

Family RHINOCEROTIDAE.

Ceratotherium simum (Burch.). White rhinoceros.
- (I.I.) *Dermacentor rhinocerotis* (De Geer).
- (I.I.) *Rhipicephalus maculatus* Neu.
- (I.I.) *Amblyomma hebraeum* Koch.
- (I.I.) *Amblyomma petersi* Karsch.

Diceros bicornis (Linné). Black rhinoceros.
- (I.I.) *Dermacentor rhinocerotis* (De Geer).
- (I.I.) *Rhipicephalus maculatus* Neu.
- (I.I.) *Amblyomma hebraeum* Koch.
- (I.I.) *Amblyomma petersi* Karsch.
- (I.I.) *Amblyomma variegatum* (Fabr.).

Family EQUIDAE.

Hippotigris burchelli wahlbergi Poc. Wahlberg's zebra.
- (I.I.) *Rhipicephalus evertsi* Neu.
- (I.I.) *Rhipicephalus maculatus* Neu.

Hippotigris burchelli var.
- (I.I.) *Boophilus decoloratus* (Koch).
- (M.) *Bovicola ocellata* (Piaget).
- (S.) *Haematopinus asini* Linné.

Order TUBULIDENTATA.

Family ORYCTEROPIDAE.

Orycteropus afer (Pallas). Cape ant-bear.
- (S.) *Hybophthirus notophallus* (Neu.).
- (S.T.) *Echidnophaga larina* Jord. & Rothsch.

Order EDENTATA.

Family MANIDAE.

Smutsia temminckii (Smuts). Scaly ant-bear.
(I.I.) *Rhipicephalus simus* Koch.
(S.T.) *Echidnophaga larina* Jord. & Rothsch.

Order RODENTIA.

Family HYSTRICIDAE.

Hystrix africae-australis Ptrs. (Cape porcupine.)
(S.T.) *Echidnophaga larina* Jord. & Rothsch.
(S.P.) *Pariodontis riggenbachi* (Rothsch.).

Family PEDETIDAE.

Pedetes caffer (Pallas). Springhare.
(A.P.) *Androlaelaps sp.*
(A.P.) *Haemolaelaps sp.*
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Haemaphysalis cooleyi* Bedford.
(I.I.) *Haemaphysalis leachii* (Aud.).
(S.) *Eulinognathus denticulatus* Cumm.
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Synosternus caffer* (Jord. & Rothsch.).
(S.P.) *Ctenocephalides connatus* (Jord.)

Family PETROMYIDAE.

Petromys typicus tropicalis. Rock rat.
(S.) *Scipio nov.* sp.

Petromys nov. sp.
(S.) *Scipio nov.* sp.

Family THRYONOMYIDAE.

Thryonomys swinderianus variegatus Ptrs. Natal cane-rat.
(I.I.) *Ixodes ugandanus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus simus* Koch.
(I.I.) *Amblyomma hebraeum* Koch. (Nymphs).
(S.) *Scipio aulacodi* (Neu.).
(S.) *Scipio breviceps* Ferris.

Family SCIURIDAE.

Paraxerus cepapi (A. Smith). Yellow-footed squirrel.
(I.I.) *Rhipicephalus appendiculatus* Neu.

Paraxerus palliatus ornatus (Gray). Zululand squirrel.
(S.) *Enderleinellus zonatus* Ferris.
(S.) *Neohaematopinus heliosciuri* Cummings.
(S.) *Neohaematopinus suahelicus* Ferris.

Geosciurus capensis Kerr. Cape ground squirrel.

(A.P.) *Haemolaelaps* sp.
(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Rhipicephalus theileri* Bedf. & Hewitt.
(S.) *Linognathoides faurei* Bedford.
(S.T.) *Echidnophaga bradyta* Jord. & Rothsch.
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Pulex irritans* Linné. (Straggler).
(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Xenopsylla erilli* (Rothsch.).
(S.P.) *Ctenocephalides connatus* (Jord.).
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch. (Straggler).

Family GRAPHIURIDAE.

Claviglis ocularis (A. Smith). Cape dormouse.
(S.P.) *Chiastopsylla octavii* Rothsch.

Claviglis nanus (de Winton). Rhodesian least grey dormouse.
(S.) *Schizophthirus graphiuri* Ferris.

Claviglis alticola Roberts.
(S.) *Schizophthirus graphiuri* Ferris.

Claviglis murinus (Desm.).
(S.P.) *Xenopsylla hamula* Jord.

Family CRICETIDAE.

Subfamily CRICETINAE.

Mystromys albicaudatus (A. Smith). White-tailed rat.

(S.P.) *Xenopsylla cheopis* (Rothsch.).
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Listropsylla agrippinae* (Rothsch.).
(S.P.) *Dinopsyllus ellobius* Rothsch.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Subfamily GERBILLINAE.

Desmodillus auricularis (A. Smith). Short-tailed gerbille.

(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Xenopsylla piriei* Ingram.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Tatera afra (Gray). Cape gerbille.

(S.P.) *Xenopsylla hirsuta* Ingram.
(S.P.) *Xenopsylla sulcata* Ingram.
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Listropsylla agrippinae* (Rothsch.).
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Tatera angolae Wr. Angola gerbille.

(S.) *Hoplopleura biseriata* Ferris.

Tatera lobengulae de Winton. Lobengula's gerbille.

(A.P.) *Laelaps muricola* Trägardh.
(A.P.) *Haemolaelaps* sp.
(I.I.) *Ixodes pilosus* Koch.
(I.I.) *Haemaphysalis leachii* (Aud.).
(S.) *Polyplax biseriata* Ferris.
(S.) *Hoploplenra biseriata* Ferris.
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Xenopsylla hirsuta* Ingram.
(S.P.) *Xenopsylla lobengulae* De Meillon.
(S.P.) *Xenopsylla piriei* Ingram.
(S.P.) *Xenopsylla sulcata* Ingram.
(S.P.) *Xenopsylla trifarius* De Meillon.
(S.P.) *Chiastopsylla mulleri* Ingram.
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Listropsylla agrippinae* (Rothsch.).
(S.P.) *Listropsylla chelura* Rothsch.
(S.P.) *Listropsylla dorippae* (Rothsch.).
(S.P.) *Ctenophthalmus calceatus* Waterst.
(S.P.) *Dinopsyllus longifrons* Jord. & Rothsch.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.
(S.P.) *Leptopsylla segnis* (Schönh.). (Straggler).

Family MURIDAE.

Subfamily OTOMYINAE.

Otomys irroratus (Brants). African water rat.

(A.P.) *Laelaps parvulus* Hirst.
(I.I.) *Haemaphysalis leachii* (Aud.).
(S.) *Polyplax otomydis* Cummings.
(S.P.) *Xenopsylla cheopis* (Rothsch.).
(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Chiastopsylla numae* (Rothsch.).
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Listropsylla agrippinae* (Rothsch.).
(S.P.) *Listropsylla chelura* (Rothsch.).
(S.P.) *Dinopsyllus ellobius* Rothsch.
(S.P.) *Dinopsyllus longifrons* Jord. & Rothsch.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Myotomys turneri (Wrough.). Turner's Karroo rat.

(S.P.) *Listropsylla agrippinae* (Rothsch.).

Myotomys broomi (Thos.). Broom's Karroo rat.

(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Xenopsylla piriei* Ingram.
(S.P.) *Chiastopsylla mulleri* Ingram.
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Listropsylla agrippinae* (Rothsch.).
(S.P.) *Listropsylla cerrita* Jord.
(S.P.) *Listropsylla dorippae* (Rothsch.).
(S.P.) *Dinopsyllus tenax* Jord.
(S.P.) *Hypsophthalmus aganippes* (Rothsch.).

Myotomys unisulcatus (Cuv.). Cuvier's Karroo rat.
- (S.P.) *Listropsylla agrippinae* (Rothsch.).

Myotomys granti (Thos.). Grant's Karroo rat.
- (S.P.) *Xenopsylla eridos* (Rothsch.).
- (S.P.) *Chiastopsylla pitchfordi* Ingram.
- (S.P.) *Chiastopsylla rossi* (Waterst.).
- (S.P.) *Listropsylla agrippinae* (Rothsch.).
- (S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Paratomys brantsi (A. Smith). Brant's Karroo rat.
- (S.P.) *Xenopsylla eridos* (Rothsch.).
- (S.P.) *Chiastopsylla numae* (Rothsch.).
- (S.P.) *Listropsylla agrippinae* (Rothsch.).
- (S.P.) *Listropsylla dorippae* (Rothsch.).

Paratomys luteolus (Thos. & Schw.). Eastern Karroo rat.
- (S.) *Polyplax otomydis* Cumm.
- (S.P.) *Xenopsylla eridos* (Rothsch.).
- (S.P.) *Xenopsylla piriei* Ingram.
- (S.P.) *Chiastopsylla mulleri* Ingram.
- (S.P.) *Chiastopsylla numae* (Rothsch.).
- (S.P.) *Chiastopsylla pitchfordi* Ingram.
- (S.P.) *Chiastopsylla quadrisetis* De Meillon.
- (S.P.) *Chiastopsylla rossi* (Waterst.).
- (S.P.) *Listropsylla agrippinae* (Rothsch.).
- (S.P.) *Listropsylla cerrita* Jord.
- (S.P.) *Dinopsyllus longifrons* Jord. & Rothsch.
- (S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.
- (S.P.) *Dinopsyllus tenax* Jord.
- (S.P.) *Hypsophthalmus aganippes* (Rothsch.).

Subfamily DENDROMYINAE.

Malacothrix typicus (A. Smith). Large-eared mouse.
- (S.) *Hoplopleura biseriata* Ferris.
- (S.P.) *Xenopsylla eridos* (Rothsch.).
- (S.P.) *Listropsylla dorippae* (Rothsch.).
- (S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Steatomys krebsi Ptrs. Cape fat mouse.
- (S.P.) *Listropsylla dorippae* (Rothsch.).
- (S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Subfamily CRICETOMYINAE.

Cricetomys gambianus Waterh. Giant rat.
- (D.) *Hemimerus talpoides* Walker.
- (S.) *Polyplax calva* Waterst.
- (S.P.) *Xenopsylla scopulifer* (Rothsch.).
- (S.P.) *Xenopsylla tortus* Jord. & Rothsch.

Subfamily SACCOSTOMYINAE.

Saccostomys campestris (Ptrs.). Peter's pouched mouse.
- (S.) *Polyplax jonesi* Kellogg & Ferris.
- (S.P.) *Xenopsylla scopulifer* (Rothsch.).

Subfamily MURINAE.

Mus musculus Linné. House mouse.

No parasites have been found on this mouse in South Africa.

Leggada minutoides (A. Smith). Dwarf mouse.
(S.P.) *Listropsylla prominens* Jordan.

Leggada deserti Thos. Desert dwarf mouse.
(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Listropsylla dorippae* (Rothsch.).
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Rhabdomys pumilio (Sparrm.). Striped mouse.
(A.P.) *Laelaps giganteus bakeri* Hirst.
(A.P.) *Laelaps muricola* Trägardh.
(I.I.) *Haemaphysalis leachii* (Aud.).
(S.) *Polyplax arvicanthis* Bedford.
(S.P.) *Xenopsylla brasiliensis* (Baker).
(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Xenopsylla hirsuta* Ingram.
(S.P.) *Xenopsylla versuta* Jordan.
(S.P.) *Chiastopsylla godfreyi* Waterst.
(S.P.) *Chiastopsylla octavii* Rothsch.
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Listropsylla agrippinae* (Rothsch.).
(S.P.) *Listropsylla chelura* Rothsch.
(S.P.) *Ctenophthalmus calceatus* Waterst.
(S.P.) *Dinopsyllus ellobius* (Rothsch.).
(S.P.) *Dinopsyllus longifrons* Jord. & Rothsch.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Lemniscomys spinalis Thos. (*Arvicanthis dorsalis*). Bushveld striped mouse.
(A.P.) *Laelaps giganteus* Berlese.
(A.P.) *Laelaps parvulus* Hirst.
(S.) *Hoplopleura enormis enormis* Kellogg & Ferris.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Rattus rattus (Linné). Black rat.
(A.S.) *Notoedres notoedres* (Méigen).
(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Hyalomma aegyptium impressum* Koch. (Immature).
(S.) *Polyplax spinulosa* (Burm.).
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Xenopsylla brasiliensis* (Baker).
(S.P.) *Xenopsylla cheopis* (Rothsch.).
(S.P.) *Ceratophyllus fasciatus* (Bosc.).
(S.P.) *Ceratophyllus londiniensis* Rothsch.
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Dinopsyllus longifrons* Jord. & Rothsch.
(S.P.) *Leptopsylla segnis* (Schönh.).

Rattus norvegicus (Erxl.). Brown rat.
(S.) *Polyplax spinulosa* (Burm.).
(S.P.) *Xenopsylla cheopis* (Rothsch.).
(S.P.) *Ceratophyllus fasciatus* (Bosc.).
(S.P.) *Leptopsylla segnis* (Schönh.).

Aethomys chrysophilus (de Winton). African rat.
(A.P.) *Laelaps vansomereni* Hirst.
(S.) *Polyplax cummingsi* Ferris.
(S.P.) *Xenopsylla brasiliensis* (Baker).
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Listropsylla prominens* Jord.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.

Thallomys moggi (Roberts). Mogg's black-tailed rat.
(S.) *Polyplax spinulosa* (Burm.).
(S.) *Hoplopleura affinis* (Burm.).
(S.P.) *Xenopsylla cheopis* (Rothsch.).
(S.P.) *Chiastopsylla numae* (Rothsch.).

Praomys arborarius Peters. Golden rock mouse.
(S.P.) *Praopsylla powelli* Ingram.
(S.P.) *Xenopsylla scopulifer* (Rothsch.).
(S.P.) *Xenopsylla tortus* Jord. & Rothsch.

Praomys namaquensis grahami (Rbts.). Albany rock mouse.
(I.I.) *Rhipicephalus simus* Koch.
(S.P.) *Chiastopsylla godfreyi* Waterst.
(S.P.) *Listropsylla agrippinae* (Rothsch.).

Praomys namaquensis monticularis Jameson.
(S.) *Polyplax praomydis* Bedford.
(S.P.) *Chiastopsylla octavii* (Rothsch.).

Myomys colonus (Brants). Brant's mouse.
(S.P.) *Stivalius ahalae* (Rothsch.).
(S.P.) *Stivalius aporus* Jord. & Rothsch.

Mastomys coucha (A. Smith). Multimammate mouse.
(A.P.) *Laelaps muricola* Trägardh.
(I.I.) *Ixodes nairobiensis* Nuttall.
(S.) *Polyplax waterstoni* Bedford.
(S.) *Hoplopleura intermedia* Kellogg & Ferris.
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.T.) *Echidnophaga larina* Jord. & Rothsch.
(S.P.) *Xenopsylla brasiliensis* (Baker).
(S.P.) *Xenopsylla cheopis* (Rothsch.).
(S.P.) *Xenopsylla eridos* (Rothsch.).
(S.P.) *Chiastopsylla numae* (Rothsch.).
(S.P.) *Chiastopsylla rossi* (Waterst.).
(S.P.) *Dinopsyllus longifrons* Jord. & Rothsch.
(S.P.) *Dinopsyllus lypusus* Jord. & Rothsch.
(S.P.) *Listropsylla prominens* Jord.

Mastomys coucha silaceus (Wagner).
(A.P.) *Laelaps muricola* Trägardh.

Dasymys incomtus (Sund.).
(S.) *Polyplax cummingsi* Ferris.

Family BATHYERGIDAE.

Subfamily BATHYERGINAE.

Bathyergus suillus (Schreb.). (*B. maritimus* Gm.). Cape dune mole.

(S.) *Proenderleinellus lawrensis* (Bedford).
(S.P.) *Dinopsyllus ingens* Rothsch.

Subfamily HELIPHOBINAE.

Cryptomys capensis (Cuv.). [*Georychus capensis* (Cuv.)]. Cape blesmol.

(S.P.) *Dinopsyllus ingens* Rothsch.

Cryptomys hottentotus (Less.). Hottentot male rat.

(Syn. *Georychus hottentotus* Less.)

(A.D.[2]) *Myomyssoides capensis* Hirst.
(A.P.) *Haemolaelaps capensis* Hirst.
(S.) *Proenderleinellus hilli* (Bedford).

Order LAGOMORPHA.

Family LEPORIDAE.

Pronolagus crassicaudatus (I. Geoff.). Cape red hare.

(I.I.) *Ixodes rubicundus* Neu.
(I.I.) *Haemaphysalis leachii* (Aud.).

Lepus capensis Linné. Cape hare.

(I.I.) *Haemaphysalis leachii* (Aud.).
(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu.
(I.I.) *Rhipicephalus oculatus* Neu.
(I.I.) *Rhipicephalus sanguineus* (Latr.).
(I.I.) *Hyalomma aegyptium impressum* Koch. (Immature stages).
(S.T.) *Echidnophaga gallinacea* (Westw.).
(S.P.) *Xenopsylla eridos* Rothsch.
(S.P.) *Ctenocephalides connatus* (Jord.).

Lepus capensis ochropus Wagn.

(I.I.) *Rhipicephalus oculatus* Neu.
(I.I.) *Hyalomma aegyptium impressum* Koch.

Lepus saxatilis F. Cuv. Great hare.

(I.I.) *Rhipicephalus capensis* Koch.
(S.P.) *Xenopsylla eridos* Rothsch.

Lepus zuluensis Thos. & Schw. Zulu hare.

(I.I.) *Rhipicephalus appendiculatus* Neu.
(I.I.) *Rhipicephalus evertsi* Neu. (Immature stages).
(I.I.) *Rhipicephalus oculatus* Neu. (Adults).
(I.I.) *Boophilus decoloratus* (Koch).
(I.I.) *Hyalomma aegyptium impressum* Koch. (Immature stages).
(I.I.) *Amblyomma hebraeum* Koch. (Nymphs).
(S.P.) *Ctenocephalides felis* (Bouché).

Order CHIROPTERA.

Suborder MICROCHIROPTERA.

Family RHINOLOPHIDAE.

Rhinolophus geoffroyii augur Anders. Namaqua augur bat.

(I.I.) *Ixodes pilosus* Koch. (Probably *I. simplex* Neu.).
(D.S.) *Nycteribosca kollari* (Frauenf.).
(D.N.) *Nycteribia* sp.
(S.I.) *Ischnopsyllus ashworthii* Waterst.
(S.I.) *Rhinolophopsylla capensis* Jord. & Rothsch.

Rhinolophus capensis Licht.

(D.N.) *Nycteribia scissa* Speiser.

Rhinolophus darlingi Anders.

(D.N.) *Nycteribia* sp.

Family HIPPOSIDERIDAE.

Hipposideros caffer (Sund.). African leaf-nosed bat.

(A.T.) *Leeuwenhoekia polydiscum* Oudms.
(A.T.) *Microtrombidium minutissimum* Oudms.
(A.T.) *Typhlothrombium nanus* Oudms.
(D.S.) *Raymondia huberi* Frauenf.

Family NYCTERIDAE.

Nycteris damarensis Ptrs. Damara long-eared bat.

(D.S.) *Raymondia bedfordi* Ferris.

Nycteris capensis A. Smith. Cape long-eared bat.

(D S.) *Rhinolophopsylla capensis* Jord. & Rothsch.
(D.N.) *Penicillidia fulvida* (Bigot).

Family VESPERTILLIONIDAE.

Eptesicus capensis (A. Smith). Cape house bat.

(I.A.) *Argas vespertilionis* (Latr.).
(H.C.) *Cimex pipistrelli* Jenyns.
(H.C.) *Cacodmus villosus* Stål.
(S.I.) *Ischnopsyllus comminus* Jord. & Rothsch.
(S.I.) *Ischnopsyllus grahami* Waterst.

Eptesicus capensis gracilior (Thos. & Schw.).

(S.T.) *Echidnophaga gallinacea* (West.).

Myotis tricolor (Smuts).

(I.I.) *Ixodes simplex* Neu.
(S.I.) *Rhinolophopsylla capensis* Jord. & Rothsch.

Scotophilus nigrita dingani (A. Smith). Zulu great house bat.

(H.C.) *Cacodmus sparsilis* Rothsch.

Miniopterus natalensis (A. Smith). Natal sociable bat.

(I.A.) *Argas vespertilionis* (Latr.).
(D.N.) *Penicillidia fulvida* (Bigot).
(S.I.) *Ischnopsyllus isomalus* Waterst.
(S.I.) *Rhinolophopsylla capensis* Jord. & Rothsch.

Nyctinomus aegyptiacus (E. Geoff.). Egyptian free-tailed bat.
(S.I.) *Araeopsylla scitulus* (Rothsch.).
Nyctinomus bocagei Seabra. Bocage's free-tailed bat.
(S.I.) *Araeopsylla scitulus* (Rothsch.).

Family PTEROPODIDAE.
Eidolon helvum (Kerr). Long-winged fruit bat.
(S.I.) *Thaumapsylla breviceps* Rothsch.
Roussetus leachi A. Smith. Cape fruit bat.
(S.I.) *Thaumapsylla breviceps* Rothsch.
"Bats."
(S.T.) *Echidnophaga aethiops* Jord. & Rothsch.
(D.S.) *Nycteribosca africana* Walk.
(D.N.) *Eucampsipodia hyrtli* (Kolenati).

Order PRIMATES.

Suborder LEMUROIDEA.

Family GALAGIDAE.
Galago moholi (A. Smith). Moholi night ape.
(S.) *Lemurphthirus galagus* Bedford.

Suborder ANTHROPOIDEA.

Family CERCOPITHECIDAE.
Papio griseipes (Poc.). Chaema baboon.
[Syn. *Papio porcarius* (Brünn.)].
(I.I.) *Rhipicephalus evertsi* Neu. (Nymphs).
(S.) *Pedicinus hamadryas* Mjöberg.
Cercopithecus aethiops (Cuv.). Vervet monkey.
[Syn. *C. pygerythrus* (Cuv.)].
(S.) *Pedicinus longiceps* Piaget.

IV.—HOST-LIST OF THE ECTOPARASITES FOUND ON SOUTH AFRICAN BIRDS.

1. Family STRUTHIONIDAE.
1. *Struthio australis* Gurn. Southern ostrich.
Parasites recorded in List No. II.

2. Family PHASIANIDAE.
2. *Pternistis swainsoni* (A. Smith). Swainson's red-necked francolin.
(M.) *Lipeurus pternistis* Bedford.
(M.) *Goniodes pternistis* Bedford.
(M.) *Gonioeotes hologaster* Nitzsch.
(M.) *Menopon francolinus* Bedford.
(M.) *Menopon powelli* Bedford.

4. *Pternistis afer* (Mull.). Angola red-necked francolin.
   (M.) *Lipeurus pternistis* Bedford.
   (M.) *Menopon powelli* Bedford.

5. *Pternistis castaneiventer krebsi* Neum. Drakensberg red-necked francolin.
   (M.) *Goniocotes hologaster* Nitzsch.
   (M.) *Menopon powelli* Bedford.

6. *Chaetopus capensis* (Gmel.). Cape noisy francolin.
   (M.) *Goniodes assimilis* Piaget.
   (M.) *Colpocephalum spinosum* Piaget.

7. *Chaetopus adspersus* (Waterh.). Red-billed noisy francolin.
   (M.) *Menopon powelli* Bedford.

11. *Dendroperdix sephaena* (A. Smith). Bush partridge.
   (M.) *Goniocotes hologaster* Nitzsch.
   (M.) *Menopon francolinus* Bedford.
   (M.) *Menopon powelli* Bedford.

15. *Scleroptila jugularis* Büttikofer. Ovambo partridge.
   (M.) *Lipeurus waterstoni* Bedford.
   (M.) *Goniodes scleroptilus* Bedford.

3. Family NUMIDIDAE.

22. *Numida papillosa* Rehw. Guinea-fowl.
   (I.A.) *Argas persicus* (Oken).
   (M.) *Lipeurus lawrensis* Bedford.
   (M.) *Goniodes numidae* Mjöberg.
   (M.) *Goniocotes gigas* Taschenberg.
   (M.) *Gioniocotes hologaster* Nitzsch.
   (M.) *Numidicola antennata* (Kellogg & Paine).
   (M.) *Neumannia numidae* (Giebel).

4. Family PTEROCLIDAE.

26. *Nyctiperdix bicinctus* (Temm.). Double-banded sand-grouse.
   (M.) *Syrrhaptoecus declivis* Waterston.

27. *Eremialector gutturalis* (A. Smith). Yellow-throated sand-grouse.
   (M.) *Syrrhaptoecus uncinosus* Waterston.

28. *Pterocles namaquus* (Gmel.). Namaqua sand-grouse.
   (M.) *Syrrhaptoecus brevifrons* Waterston.
   (M.) *Syrrhaptoecus digonus* Waterston.
   (M.) *Neomenopon pteroclurus* Bedford.

5. Family TRERONIDAE.

32. *Vinago delandei* (Bp.). Delalande's green pigeon.
   (M.) *Goniodes aegypticus* (Kellogg & Paine).
   (M.) *Columbicola columba* (Linné).

6. Family COLUMBIDAE.

33. *Dialiptila phaeonota* (Gray). Cape rock pigeon.
   (M.) *Goniodes aegypticus* (Kellogg & Paine).

36. *Streptopelia semitorquata* (Rüpp.). Red-eyed turtle dove.
    (M.) *Goniodes hilli* Bedford.
    (M.) *Esthiopterum sudanicum* (Mjöberg).

38. *Afropelia capicola* (Sund.). Cape turtle dove.
    (M.) *Goniodes aegypticus* (Kellogg & Paine).
    (M.) *Menacanthus giganteus* (Denny).

38b. *Afropelia capicola damarensis* (Finsch & Hartl.). Damara turtle dove.
    (M.) *Goniodes aegypticus* (Kellogg & Paine).
    (M.) *Esthiopterum sudanicum* (Mjöberg).
    (M.) *Columbicola columba* (Linné).

39. *Stigmatopelia senegalensis aequatorialis* (Erl.). Laughing dove.
    (M.) *Goniodes aegypticus* (Kellogg & Paine).
    (M.) *Esthiopterum sudanicum* (Mjöberg).
    (M.) *Columbicola columba* (Linné).

7. Family RALLIDAE.

45. *Lupha cristata* (Gmel.). Red-knobbed coot.
    (M.) *Rallicola cuspidata* (Scopoli).
    (M.) *Rallicola fulica* (Denny).
    (M.) *Pseudomenopon tridens* (Nitzsch).

48. *Gallinula chloropus brachyptera* Brehm. African moorhen.
    (M.) *Rallicola cuspidata* (Scopoli).
    (M.) *Rallicola fulica* (Denny).
    (M.) *Pseudomenopon tridens* (Nitzsch).

49. *Porphyriops angulata* (Sund.). Lesser moorhen.
    (M.) *Rallicola cuspidata* (Scopoli).
    (M.) *Pseudomenopon tridens* (Nitzsch).

51. *Ortygometra porzana* (Linné). Spotted crake.
    (A.A.) *Pterolichus porzanae* (Can.).
    (A.A.) *Mégninia gallinulae* (Buchh.).
    (A.A.) *Mégninia gallinulae major* Berl.
    (A.A.) *Pterodectes ortygometrae* (Can.).
    (M.) *Rallicola mystax* (Giebel).

53. *Crex crex* (Linné). Corn crake.
    (A.A.) *Pterolichus rallorum* Robin.
    (M.) *Rallicola ortygometrae* (Schrank).

9. Family HELIORNITHIDAE.

63. *Podica petersi* Hartl. Peter's finfoot.
    (A.A.) *Alloptes discosurus* Trt.
    (M.) *Esthiopterum rotundatum* (Piaget).

11. Family PODICIPIDAE.

67. *Poliocephalus capensis* (Salvad.). Cape dabchick.
    (M.) *Degeeriella kilimanjarensis* (Kellogg).

68. *Proctopus nigricollis gurneyi* (Rbts.). Cape eared grebe.
    (M.) *Degeeriella columbina* (Scop.).

69. *Podiceps infuscata* (Salvad.). African crested grebe.
 (A.A.) *Pterolichus colymbi major* Mégn. & Trt.
 (M.) *Degeeriella columbina* (Scop.).

12. Family SPHENISCIDAE.

70. *Spheniscus demersus* (Linné). Jackass penguin.
 (I.A.) *Argas talaje capensis* (Neu.).
 (M.) *Austrogoniodes bifasciatus* (Piaget).

13. Family HYDROBATIDAE.

72. *Cymochorea leucorhoa* (Vieill.). Fork-tailed petrel.
 (M.) *Degeeriella alpha* (Kellogg).

77. *Adamastor cinereus* (Gmel.). Great grey petrel.
 (M.) *Naubates fuliginosus* (Taschb.).
 (M.) *Esthiopterum angusticeps* (Piaget).
 (M.) *Esthiopterum diversum* (Kellogg).

78. *Procellaria aequinoctialis* Linné. Cape hen.
 (M.) *Naubates fuliginosus* (Taschb.).
 (M.) *Esthiopterum diversum* (Kellogg)
 (M.) *Giebelia hexakon* Waterston.
 (M.) *Docophoroides brevis* (Dufour).
 (M.) *Docophoroides simplex* (Waterston).

79. *Petrodroma macroptera* (A. Smith). Cape parson.
 (M.) *Naubates pterodromi* Bedford.
 (M.) *Trabeculus schillingi* Rudow.

80. *Pterodroma incerta* (Schlegel). Brown petrel.
 (M.) *Naubates fuliginosus* (Taschb.).
 (M.) *Esthiopterum diversum* (Kellogg).
 (M.) *Ancistrona vagelli* (Fabr.).

82. *Pterodroma mollis* (J. Gould). Soft-plumed petrel.
 (M.) *Naubates fuliginosus* (Taschb.).
 (M.) *Esthiopterum diversum* (Kellogg).
 (M.) *Trabeculus schillingi* (Rudow).
 (M.) *Ancistrona vagelli* (Fabr.).
 (M.) *Colpocephalum furcatum* Rudow.

83. *Ardenna gravis* (O'Reil). Great shear-water.
 (M.) *Naubates harrisoni* Bedford.
 (M.) *Giebelia hexakon* Waterston.

85. *Neonectris griseus* (Gm.). Sooty shear-water.
 (M.) *Ancistrona vagelli* (Fabr.).

87. *Daption capensis* (Linné). Cape sea-pigeon.
 (A.A.) *Microspalax manicata major* Trt. & Neum.
 (M.) *Naubates fuliginosus* (Taschb.).
 (M.) *Esthiopterum nigrolimbatum* (Giebel).
 (M.) *Ancistrona vagelli* (Fabr.).
 (M.) *Pseudonirmus gurlti* (Taschb.).

88. *Macronectes giganteus* (Gmel.). Giant petrel.
  (M.) *Esthiopterum obscurum* (Rudow).
  (M.) *Trabeculus schillingi* Rudow.
  (M.) *Docophoroides murphyi* (Kellogg).
  (M.) *Naubates fuliginosus* (Taschb.).

14. Family OCEANITIDAE.

89. *Oceanites oceanicus* (Kuhl.). Sooty petrel.
  (M.) *Naubates fuliginosus* (Taschb.).
  (M.) *Esthiopterum diversum* (Kellogg).
  (M.) *Trabeculus schillingi* Rudow.
  (M.) *Ancistrona vagelli* (Fabr.).

15. Family DIOMEDEIDAE.

92. *Diomedea exulans* Linné. Wandering albatross.
  (M.) *Harrisoniella diomedea* (Fabr.).
  (M.) *Naubates fuliginosus* (Taschb.).
  (M.) *Esthiopterum giganticola* (Kellogg).
  (M.) *Docophoroides brevis* (Dufour).
  (M.) *Colpocephalum pingue* Kellogg.

93. *Thalassarche melanophrys* (Boie). Mollymawk.
  (M.) *Harrisoniella diomedea* (Fabr.).
  (M.) *Naubates fuliginosus* (Taschb.).
  (M.) *Esthiopterum diversum* (Kellogg). Straggler?
  (M.) *Esthiopterum giganticola* (Kellogg).
  (M.) *Esthiopterum obscurum* (Rudow).
  (M.) *Docophoroides harrisoni* Waterston.
  (M.) *Docophoroides murphyi* (Kellogg).
  (M.) *Docophoroides simplex* (Waterston).
  (M.) *Philopterus gonothorax* (Giebel). Straggler.

94. *Diomedella cauta layardi* (Salvin). Layard's albatross.
  (M.) *Esthiopterum giganticola* (Kellogg).
  (M.) *Docophoroides harrisoni* Waterston.

96. *Nealbatrus chlororhynchus* (Gmel.). Yellow-billed mollymawk.
  (A.A.) *Pterolichus rubidus* Trt.
  (A.A.) *Pterolichus rubidus petalifera* Trt.
  (M.) *Naubates fuliginosus* (Taschb.).
  (M.) *Esthiopterum giganticola* (Kellogg).
  (M.) *Esthiopterum obscurum* (Rudow).
  (M.) *Docophoroides brevis* (Dufour).
  (M.) *Docophoroides murphyi* (Kellogg).

97. *Phoebetria palpebrata* (Forst.). Sooty albatross.
  (M.) *Esthiopterum obscurum* (Rudow).

16. Family LARIDAE.

98. *Larus dominicanus* (Lcht.). Cape black-backed gull.
  (M.) *Philopterus gonothorax* (Giebel).

100. *Bruchigavia novae-hollandiae hartlaubi* Bruch. White-headed gull.
  (M.) *Degeeriella lingulata* (Waterston).
  (M.) *Philopterus gonothorax* (Giebel).

17. Family STERNIDAE.

101. *Chlidonias leucoptera* (Schinz.). White-winged tern.
(A.A.) *Thecarthra simplex tyroglyphina* (Trt. & Neum.).

103. *Hydroprogne tschegrava* (Lepech.). Caspian tern.
(A.A.) *Thecarthra theca* (Megn. & Trt.).

104. *Sterna hirundo* Linné. Common tern.
(A.A.) *Pterolichus martini* Trt.
(A.A.) *Anoplonotus semaphorus* (Trt.).
(A.A.) *Alloptes bisetatus* Haller.
(M.) *Esthiopterum parviceps* (Piaget).
(M.) *Degeeriella sellata* (Burm.).
(M.) *Philopterus laricola* (Nitzsch).
(M.) *Philopterus melanocephalus* (Nitzsch).
(M.) *Menopon pachypus* Piaget.

106. *Sterna macrura Naum.* Artic tern.
(M.) *Philopterus atlanticus* (Kellogg).

107. *Thalasseus sandricensis* (Lath.). Sandwich tern.
(A.A.) *Alloptes bisetatus* Haller.
(M.) *Degeeriella sellata* (Burm.).
(M.) *Philopterus melanocephalus* (Nitzsch).
(M.) *Menopon fuscofasciatum* Piaget.
(M.) *Actornithophilus piceus* (Denny).

109. *Thalasseus bergii* (Lcht.). Swift tern.
(M.) *Philopterus melanocephalus* (Nitzsch).
(M.) *Actornithophilus crassipes* (Piaget).
(M.) *Actornithophilus piceus* (Denny).

110. *Sternula albifrons* Pall. Little tern.
(M.) *Degeeriella nycthemera* (Nitzsch).
(M.) *Philopterus laricola* (Nitzsch).

114. *Anous stolidus* (Linné). Common noddy.
(M.) *Degeeriella emarginata* (Kellogg & Chapman).
(M.) *Degeeriella gloriosa* (Kellogg & Kuwana).
(M.) *Degeeriella hebes* (Kellogg).
(M.) *Actornithophilus epiphanes* (Kellogg & Chapman).

18. Family RHYNCHOPIDAE.

115. *Rhynchops flavirostris* Vieill. African skimmer.
(A.A.) *Freyana marginata* Trt.
(M.) *Philopterus elongatus* Piaget.
(M.) *Actornithophilus latifasciatus* (Piaget).

19. Family STERCORARIIDAE.

116. *Stercorarius parasiticus* (Linné). White-necked skua.
(A.A.) *Thecarthra theca* (Mégn. & Trt.).
(A.A.) *Alloptes bisetatus* Haller.
(M.) *Degeeriella normifer* (Grube).
(M.) *Philopterus atlanticus* (Kellogg).
(M.) *Philopterus cephalus* (Denny).

117. *Coprotheres pomarinus* (Temm.). Large white-necked skua.
- (M.) *Degeeriella normifer* (Grube).
- (M.) *Esthiopterum modestum* (Giebel).
- (M.) *Philopterus cephalus* (Denny).
- (M.) *Philopterus pustulosus* (Nitzsch).
- (M.) *Menopon circinatum* Piaget.
- (M.) *Menopon fuscofasciatum* Piaget.
- (M.) *Actornithophilus brachycephalus* (Giebel).

118. *Catharacta skua antarticus* (Less.). Southern skua.
- (M.) *Degeeriella alpha* (Kellogg).
- (M.) *Ethiopterum modestum* (Giebel).

20. Family ARENARIIDAE.

119. *Arenaria interpres* (Linné). Turnstone.
- (A.A.) *Pterolichus buchholzi fascigera* Mégn. & Trt.
- (A.A.) *Thecarthra trouessarti* Berl.
- (A.D.[2]) *Rhinonyssus coniventris* Trt.
- (M.) *Degeeriella holophaea* (Nitzsch).
- (M.) *Degeeriella strepsilaris* (Denny).
- (M.) *Menopon strepsilae* Denny.
- (M.) *Actornithophilus bicolor* (Piaget).
- (M.) *Colpocephalum pediculoides* Mjöberg.

22. Family CHARADRIIDAE.

121. *Crocethia alba* (Pall). Sanderling.
(Syn. *Calidris arenaria* Linné).
- (M.) *Degeeriella cingulata* (Nitzsch).
- (M.) *Degeeriella complexiva* (Kellogg & Chapman).
- (M.) *Degeeriella decipiens* (Nitzsch).
- (M.) *Degeeriella testudinaria* (Child).

122. *Pagoa leschenaultii* (Less.). Great sandplover.
- (M.) *Degeeriella furva* (Nitzsch).

123. *Eupodella asiatica* (Pall.). Caspian plover.
- (M.) *Degeeriella assimilis* (Piaget).

124. *Leucopolius marginatus* (Vieill.). White-fronted sand-plover.
- (M.) *Degeeriella macrocephala* (Waterston).
- (M.) *Philopterus platygaster* (Denny).

125. *Leucopolius pecuaria* Temm. Kittlitz's sandplover.
(Syn. *L. varius* Vieill.).
- (M.) *Degeeriella macrocephala* (Waterston).
- (M.) *Philopterus platygaster* (Denny).

127. *Charadrius hiaticula* Linné. Ringed plover.
- (A.A.) *Pterolichus charadrii* (Can.).
- (A.A.) *Thecarthra bouveti* (Mégn. & Trt.)
- (A.D.[2]) *Rhinonyssus echinipes* Hirst.
- (M.) *Degeeriella hiaticula* (Müller).
- (M.) *Philopterus platygaster* (Denny).

128. *Afroxechus tricollaris* (Vieill.). Three-banded sandplover.
    (M.) *Degeeriella macrocephala* (Waterston).
    (M.) *Philopterus platygaster* (Denny).

129. *Squatarola squatarola* (Linné). Grey plover.
    (A.A.) *Pterolichus squatarolae* (Can.).
    (A.A.) *Pterolichus buchholzi* (Can.).
    (A.A.) *Thecarthra longitarsa* (Mégn. & Trt.).
    (M.) *Degeeriella hospes* (Nitzsch).
    (M.) *Philopterus acanthus* (Giebel).
    (M.) *Philopterus conicus* (Denny).
    (M.) *Philopterus naumanni* (Giebel).

133. *Hoplopterus armatus* (Burch.). Blacksmith plover.
    (M.) *Degeeriella hoplopteri* Mjöberg.

134. *Xiphidiopterus albiceps* (Gould). White-crowned wattled plover.
    (M.) *Menopon albipes* Giebel.

23. Family RECURVIROSTRIDAE.

137. *Recurvirostra avosetta* Linné. Avocet.
    (M.) *Degeeriella decipiens* (Nitzsch).
    (M.) *Degeeriella hiaticula* (Müller).
    (M.) *Degeeriella signata* (Piaget).
    (M.) *Degeeriella testudinaria* (Children).
    (M.) *Menopon micrandum* Nitzsch.
    (M.) *Actornithophilus uniseriatus* (Piaget).

138. *Himantopus himantopus* (Linné). Black-winged stilt.
    (A.A.) *Pterolichus rehbergi gracilis* Mégn. & Trt.
    (M.) *Degeeriella furva* (Nitzsch).
    (M.) *Degeeriella hemichroa* (Nitzsch).
    (M.) *Degeeriella opisthotoma* (Kellogg).

24. Family SCOLOPACIDAE.

139. *Numenius arquatus* (Linné). Curlew.
    (A.A.) *Pterolichus ninnii* (Can.).
    (M.) *Degeeriella numenii* (Denny).
    (M.) *Degeeriella phaeopi* (Denny).
    (M.) *Dollabella testudinaria* (Denny).
    (M.) *Philopterus humeralis* (Denny).
    (M.) *Philopterus major* (Waterston).
    (M.) *Menopon crocatum* Nitzsch.
    (M.) *Menopon nigropleurum* Denny.
    (M.) *Actornithophilus patellatus* (Piaget).

140. *Phaeopus phaeopus* (Linné). Whimbrel.
    (A.A.) *Pterolichus numenii* (Can.).
    (M.) *Degeeriella phaeopi* (Denny).
    (M.) *Dollabella testudinaria* (Denny).
    (M.) *Philopterus acanthus* (Giebel).
    (M.) *Philopterus humeralis* (Denny).
    (M.) *Philopterus rotundus* (Rudow).
    (M.) *Menopon ambiguum* Nitzsch.
    (M.) *Colpocephalum ocellatum* R.

141. *Limosa limosa* (Linné). Black-tailed godwit.
- (A.A.) *Pterolichus buchholzi* Can.
- (A.A.) *Alloptes crassipes* (Can.).
- (A.A.) *Alloptes crassipes conura* Trt.
- (M.) *Degeeriella cingulata* (Nitzsch).
- (M.) *Philopterus limosae* (Denny).
- (M.) *Actornithophilus spinulosus* (Piaget).

142. *Vetola lapponica* (Linné). Bar-tailed godwit.
- (A.A.) *Avenzoaria limosae selenura* (Mégn. & Trt.).
- (A.A.) *Thecarthra setigera* (Mégn. & Trt.).
- (M.) *Degeeriella obscura* (Nitzsch).
- (M.) *Philopterus acanthus* (Giebel).
- (M.) *Menopon meyeri* Giebel.

144. *Tringa erythropus* (Vroeg.). Green sandpiper.
(Syn. *Totanus ochrophus* L.).
- (A.A.) *Syringobia calceata* Trt.
- (A.C.[2]) *Syringophilus helleri* Oudms.
- (M.) *Degeeriella ochropi* (Denny).
- (M.) *Esthiopterum emarginatum* (Piaget).
- (M.) *Actornithophilus affine* (Nitzsch).

145. *Erythroscelis fuscus* (Linné). Dusky sandpiper.
- (A.A.) *Avenzoaria asiatica* (Oudms.).
- (A.A.) *Avenzoaria australis* (Oudms.).
- (A.A.) *Avenzoaria limosae* (Buchh.).
- (A.A.) *Syringobia calcarata* Oudms.

146. *Actitis hypoleucos* (Linné). Common sandpiper.
- (M.) *Degeeriella obscura* (Nitzsch).

147. *Terekia cinerea* (Gulden). Terek sandpiper.
- (M.) *Degeeriella fulvofasciata* (Grube).

148. *Totanus totanus* (Linné). Redshank.
(Syn. *Totanus calidris*).
- (A.A.) *Pterolichus buchholzi fascigera* Mégn. & Trt.
- (A.A.) *Avenzoaria bengalensis* (Oudms.).
- (A.A.) *Avenzoaria calidridis* (Oudms.).
- (A.A.) *Avenzoaria grallatoris* (Oudms.).
- (A.A.) *Avenzoaria indica* (Oudms.).
- (A.A.) *Avenzoaria limicolae* (Oudms.).
- (A.A.) *Avenzoaria totani* (Can.).
- (A.A.) *Avenzoaria tringae* (Oudms.).
- (A.A.) *Thecarthra bouveti* (Mégn. & Trt.).
- (A.A.) *Sammonia interfolia* (Mégn. & Trt.).
- (A.A.) *Syringobia calidridis* Oudms.
- (A.A.) *Syringobia chelopus* Trt. & Neu.
- (A.A.) *Syringobia totani* Oudms.
- (A.A.) *Plutarchia chelopus* (Trt.).
- (A.A.) *Pteronyssus gracilipes* Trt. & Neu.
- (A.A.) *Alloptes gambettae* Oudms.
- (A.C.[2]) *Syringophilus totani* Oudms.
- (A.C.[2]) *Cheletopsis anax* Oudms.
- (A.C.[2]) *Cheletopsis animosa* Oudms.

(A.C.[2]) *Cheletopsis basilica* Oudms.
(A.C.[2]) *Cheletopsis impavida* Oudms.
(M.) *Menopon nigropleurum* Denny.

149. *Glottis nebularius* (Gunn.). Greenshank.
(Syn. *Totanus glottis*).
(A.A.) *Sphaerogastra thylacodes* Trt.
(M.) *Degeeriella furva* (Nitzsch).

150. *Rhyacophilus glareola* (Linné). Wood sandpiper.
(M.) *Philopterus glareolae* (Giebel).
(M.) *Degeeriella obscura* (Burmeister).

151. *Philomachus pugnax* (Linné). Ruff and reeve.
(A.A.) *Avenzoaria totani* (Can.).
(A.A.) *Avenzoaria tringae* (Oudms.). (?).
(A.A.) *Alloptes crassipes* (Can.).
(A.A.) *Alloptes crassipes conura* Trt.
(M.) *Degeeriella holophaea* (Nitzsch).
(M.) *Degeeriella scalaris* (Piaget).
(M.) *Menopon lutescens* Nitzsch.
(M.) *Menopon nigropleurum* Denny.
(M.) *Actornithophilus pustulosus* (Piaget).
(M.) *Actornithophilus umbrinus* (Nitzsch).

152. *Pisobia minuta* (Leisl.). Little stint.
(A.A.) *Avenzoaria totani* (Can.).
(A.A.) *Avenzoaria tringae* (Oudms.). (?).
(M.) *Degeeriella actophila* (Kell. & Chap.).
(M.) *Degeeriella cingulata* (Nitzsch).
(M.) *Degeeriella zonaria* (Nitzsch).
(M.) *Philopterus fusiformis* (Denny).
(M.) *Actornithophilus trilobatus* (Giebel).

153. *Erolia testacea* (Vroeg.). Curlew sandpiper.
(A.A.) *Pterolichus buchholzi securicata* Mégn. & Trt.
(A.A.) *Dermoglyphus diplectrum* Trt.
(A.A.) *Sphaerogastra thylacodes* Trt.
(M.) *Degeeriella actophila* (Kell. & Chap.).
(M.) *Degeeriella brevipes* (Piaget).
(M.) *Degeeriella zonaria* (Nitzsch).
(M.) *Philopterus fusiformis* (Denny).
(M.) *Actornithophilus umbrinus* (Nitzsch).
(M.) *Actornithophilus umbrosus* (Harrison).

154. *Calidris canutus* (Linné). Knot.
(A.A.) *Pterolichus buchholzi fascigera* Mégn. & Trt.
(M.) *Degeeriella holophaea* (Nitzsch).
(M.) *Philopterus fusiformis* (Denny).

155. *Capella media* (Frisch). Double snipe.
(M.) *Philopterus auratus* (Nitzsch).

156. *Capella nigripennis* (Bp.). Ethiopian snipe.
(M.) *Degeeriella scolopacis* (Denny).

157. *Rostratula benghalensis* (Linné). Painted snipe.
(M.) *Degeeriella quadrisetacea* (Piaget).
(M.) *Pseudomenopon rostratulum* Bedford.

25. Family CURSORIIDAE.

162. *Smutsornis africanus* (Temm.). Two-banded courser.
(A.A.) *Pterodectes ortygometrae furcifer* (Trt.).

27. Family DROMADIDAE.

166. *Dromas ardeola* (Payk.). Crab plover.
(A.A.) *Giebelia puffini* (Buchh.).
(A.A.) *Alloptes crassipes myosura* Trt.
(M.) *Degeeriella brunnea* (Nitzsch).
(M.) *Degeeriella stictochroa* (Nitzsch).

28. Family BURHINIDAE.

168. *Burhinops capensis* (Lcht.). Cape thickknee.
(I.I.) *Hyalomma aegyptium* (Linné).

29. Family OTIDAE.

169. *Choriotis kori* (Burch.). Giant bustard.
(M.) *Otilipeurus kori* Bedford.
(M.) *Otidoecus dimorphus* Bedford.
(D.H.) *Olfersia pilosa* Macq.

176. *Afrotis afroides* A. Smith. White-quilled bustard.
(D.H.) *Olfersia pilosa* Macq.

30. Family BALEARICIDAE (=Gruidae).

182. *Balearica regulorum* (Benn.). Crowned crane.
(M.) *Esthiopterum gruis* (Linné).
(M.) *Heleonomus confusus* Ferris.
(M.) *Heleonomus miandrius* (Kellogg).

31. Family PLEGADIDAE.

183. *Threskiornis aethiopica* Lath. Sacred ibis.
(M.) *Ibidoecus threskiornis* Bedford.
(M.) *Colpocephalum pygidiale* Mjöberg.

185. *Plegadis falcinellus* (Linné). Glossy ibis.
(A.A.) *Mégninia ibidis* Trt.
(A.A.) *Pteralloptes mégnini falcinelli* (Trt.).
(M.) *Degeeriella sacra* (Giebel).
(M.) *Colpocephalum fusconigrum* Giebel.

186. *Hagedashia hagedash* (Lath.). Hadadah ibis.
(A.A.) *Freyana oblonga* Trt. & Neum.
(A.A.) *Pterolichus marginatus* Trt.
(M.) *Esthiopterum capitatum* (Piaget).
(M.) *Colpocephalum subpenicillatum* Piaget.
(M.) *Eulaemobothrion kelloggi* (Bedford).

32. Family PLATALEIDAE.

187. *Platalea alba* Scop. African spoonbill.
(M.) *Ibidoecus plataleae* (Denny).
(M.) *Eucolpocephalum robustum* Bedford.

33. Family CICONIIDAE.

188. *Ibis ibis* (Linné). Wood ibis.
(A.A.) *Halleria ceratorhina* Trt.

189. *Sphenorhynchus abdimi* Lcht. White-bellied stork.
(M.) *Neophilopterus abdimius* Bedford.

190. *Dissoura episcopus* (Bodd.). Woolly-necked stork.
(M.). *Neophilopterus episcopi* (Kellogg).

192. *Ciconia ciconia* (Linné). White stork.
(A.A.) *Freyana pelargica* Trt. & Mégn.
(A.A.) *Pterolichus ciconiae* Can. & Berl.
(A.A.) *Xoloptes didactylus* Trt.
(M.) *Colpocephalum quadripustulatum* Nitzsch.
(M.) *Colpocephalum zebra* Nitzsch.
(M.) *Neophilopterus incompletus* (Nitzsch).
(M.) *Esthiopterum ciconiae* (Linné).

193. *Melanopelargus niger* (Linné). Black stork.
(A.A.) *Freyana pelargica* Trt. & Mégn.
(M.) *Esthiopterum ciconiae* (Linné).
(M.) *Neophilopterus tricolor* (Nitzsch).
(M.) *Colpocephalum ferrisi* Bedford.
(M.) *Colpocephalum quadripustulatum* Nitzsch.

194. *Anastomus lamelligerus* Temm. Openbill stork.
(M.) *Esthiopterum lepidum* (Nitzsch).
(M.) *Philopterus platyclypeatus* (Piaget).
(M.) *Colpocephalum occipitale* Nitzsch.

195. *Ephippiorhynchus senegalensis* (Shaw). Saddle-bill stork.
(A.A.) *Freyana gracilipes* Trt. & Mégn.
(M.) *Rallicola turbinata* (Piaget).
(M.) *Neophilopterus episcopi* (Kellogg).
(M.) *Colpocephalum ephippiorhynchi* Mjöberg.
(M.) *Colpocephalum oreas* Kellogg.
(M.) *Colpocephalum subflavescens* Piaget.

196. *Leptoptilus crumeniferus* (Less.). Marabou stork.
(A.A.) *Pterolichus serrativentris* Trt.
(M.) *Esthiopterum ciconiae* (Linné).
(M.) *Esthiopterum genitale* (Piaget).
(M.) *Colpocephalum longissimum* Rudow.

34. Family SCOPIDAE.

197. *Scopus umbretta bannermani* Grant. Hammerhead.
(A.A.) *Freyana pectinata* Trt.
(A.A.) *Pseudalloptes pyriventris* Trt.
(A.A.) *Pseudalloptes pyriventris vegetans* Trt.
(M.) *Degeeriella umbrina* (Nitzsch).
(M.) *Menopon madagascariense* Mjöberg.
(M.) *Colpocephalum scopinum* Mjöberg.

35. Family ARDEIDAE.

198. *Ardea cinerea* Linné. Common grey heron.

(M.) *Esthiopterum ardeae* (Linné).
(M.) *Colpocephalum decimfasciatum* Bois. & Lac.
(D.H.) *Lynchia ardeae* (Macq.)

199. *Ardea melanocephala* Vig. & Child. Black-headed heron.

(M.) *Colpocephalum decimfasciatum* Bois. & Lac.

201. *Pyrrherodia purpurea* (Linné). Purple heron.

(M.) *Esthiopterum leucoproctum* (Nitzsch).
(M.) *Colpocephalum trochioxum* Nitzsch.
(D.H.) *Lynchia ardeae* (Macq.).

202. *Casmerodius albus* (Linné). Great white heron.

(M.) *Neophilopterus episcopi* (Kellogg). Straggler?
(M.) *Colpocephalum oreas* Kellogg.
(M.) *Colpocephalum veratrum* Kellogg.

204. *Egretta garbetta* (Linné). Little egret.

(M.) *Colpocephalum decimfasciatum* var.
(D.H.) *Lynchia ardeae* (Macq.).

205. *Bubulcus ibis* (Linné). Buff-backed egret.

(D.H.) *Lynchia ardeae* (Macq.).

206. *Ardeola ralloides* (Scop.). Squacca heron.

(M.) *Colpocephalum vittatum* Rudow.
(M.) *Colpocephalum zonatum* Rudow.

212. *Ixobrychus minutus* (Linné). European little bittern.

(M.) *Philopterus sulcatus* (Piaget).
(M.) *Colpocephalum decimfasciatum* var.

213. *Nycticorax nycticorax* (Linné). Night heron.

(M.) *Colpocephalum nyctarde* Denny.

215. *Botaurus stellaris* Linné. Bittern.

(A.A.) *Pteralloptes stellaris* (Buchholz).
(M.) *Esthiopterum stellare* (Denny).
(M.) *Philopterus ovatus* (Giebel).
(M.) *Colpocephalum trochioxum* Nitzsch.

36. Family PHOENICOPTERIDAE.

216. *Phoenicopterus major* Dumont. Greater flamingo.

(A.A.) *Halleria hirsutirostris* Trt. & Mégn.
(A.A.) *Pterolichus phoenicopteri* Mégn. & Trt.
(M.) *Esthiopterum subsignatum* (Giebel).
(M.) *Philopterus pygaspis* (Nitzsch).
(M.) *Colpocephalum heterosoma* Piaget.
(M.) *Trinoton femoratum* Piaget.

37. Family ANATIDAE.

218. *Plectropterus gambensis* (Linné). Spurwing goose.

(M.) *Acidoproctus marginatus* Piaget.
(M.) *Acidoproctus rostratus* (Rudow).
(M.) *Esthiopterum anseris* (Linné).
(M.) *Esthiopterum asymmetricum* (Rudow).
(M.) *Menopon tumidum* Piaget.
(M.) *Trinoton anserinum* (Fabr.).

219. *Sarkidiornis melanotus africanus* Eyt. Knob-billed duck.

(M.) *Acidoproctus marginatus* Piaget.
(M.) *Anatoecus ferrugineus* (Giebel).
(M.) *Menopon tumidum* Piaget.
(M.) *Trinoton aculeatum* Piaget.
(M.) *Trinoton querquedulae* (Linné).

221. *Dendrocygna viduata* (Linné). White-faced duck.

(M.) *Acidoproctus marginatus* Piaget.
(M.) *Anatoecus icterodes* (Nitzsch).
(M.) *Menopon tumidum* Piaget.
(M.) *Trinoton aculeatum* Piaget.

222. *Dendrocygna bicolor* (Vieill.). Whistling duck.

(M.) *Anatoecus icterodes* (Nitzsch).

223 *Alopochen aegyptiacus* (Linné). Egyptian goose.

(A.A.) *Bdellorhynchus psalidurus* Trt.
(A.A.) *Pterodectes gynurus* (Trt.).
(M.) *Acidoproctus rostratus* (Rudow).
(M.) *Esthiopterum asymmetricum* (Rudow).
(M.) *Menopon tumidum* Piaget.
(M.) *Trinoton anserinum* (Fabr.).

224. *Casarca cana* (Gm.). South African shelduck.

(M.) *Acidoproctus marginatus* Piaget.
(M.) *Menopon tumidum* Piaget.
(M.) *Trinoton aculeatum* Piaget.
(M.) *Trinoton querquedulae* (Linné).

227. *Paecilonitta erythorhyncha* (Gm.). Red-billed teal.

(M.) *Acidoproctus marginatus* Piaget.
(M.) *Esthiopterum crassicorne* (Scop.).
(M.) *Menopon tumidum* Piaget.
(M.) *Trinoton querquedulae* (Linné).

228. *Notonetta capensis* (Gm.). Cape wigeon.

(M.) *Esthiopterum crassicorne* (Scop.).
(M.) *Trinoton querquedulae* (Linné).

230. *Spatula clypeata* (Linné). European shoveller.

(A.A.) *Bdellorhynchus polymorphus* Trt.
(M.) *Esthiopterum crassicorne* (Scop.).
(M.) *Anatoecus ferrugineus* (Giebel).
(M.) *Trinoton querquedulae* (Linné).

232. *Thalassornis leuconotus* (A. Smith). White-backed duck.
- (M.) *Acidoproctus marginatus* Piaget.
- (M.) *Anatoccus icterodes* (Nitzsch).
- (M.) *Menopon tumidum* Piaget.
- (M.) *Trinoton aculeatum* Piaget.

234. *Nyroca capensis* Less. South African pochard.
- (M.) *Trinoton querquedulae* (Linné).

38. Family PHALACROCORACIDAE.

235. *Phalacrocorax lucidus* (Lcht.). South African cormorant.
- (M.) *Pectinopygus longicornis* (Piaget).
- (M.) *Menopon sigmoidale* Pic.

236. *Pseudocarbo capensis* (Sparrm.). Cape cormorant.
- (M.) *Pectinopygus acutifrons* (Rudow).
- (M.) *Menopon brevipalpe* Piaget.
- (M.) *Menopon pellucidum* Rudow.

237. *Anacarbo neglecta* (Wahlb.). Bank cormorant.
- (M.) *Pectinopygus acutifrons* (Rudow).

238. *Microcarbo africana* (Gm.). Reed cormorant.
- (M.) *Pectinopygus afer* (Kellogg).
- (M.) *Pectinopygus setosus* (Piaget).
- (M.) *Menopon eulasium* Kellogg.

239. *Microcarbo coronata* (Wahlb.). Crowned cormorant.
- (M.) *Pectinopygus afer* (Kellogg).

39. Family ANHINGIDAE.

240. *Anhinga rufa levaillanti* (Lcht.). Cape snake bird.
- (M.) *Pectinopygus setosus* (Piaget).

40. Family SULIDAE.

241. *Sulita capensis* (Lcht.). Malagus.
- (M.) *Pectinopygus bassanae* (Fabr.).
- (M.) *Menopon pustulosum* Nitzsch.
- (S.T.) *Echidnophaga gallinacea* (Westw.).

41. Family FREGATIDAE.

244. *Fregata minor* Gmel. Frigate bird.
- (M.) *Pectinopygus gracilicornis* (Piaget).
- (M.) *Menopon intermedium* Piaget.
- (M.) *Colpocephalum angulaticeps* Piaget.
- (D.H.) *Olfersia spinifera* (Leach).

42. Family PHAETONTIDAE.

246. *Leptophaeton lepturus* (Daud.). Tropic bird.
- (M.) *Pectinopygus majus* (Kellogg 1914), *nec* Piaget, 1880. (Straggler?).

43. Family PELECANIDAE.

246a. *Pelecanus onocrotalus* (Linné). European pelican.
- (M.) *Pectinopygus forficulatum* (Nitzsch).
- (M.) *Tetrophthalmus titan* (Piaget).
- (M.) *Colpocephalum eucarenum* Nitzsch.

247. *Metapelecanus roseus* (Gm.). Eastern white pelican.
- (M.) *Tetrophthalmus subtitan* Bedford.

248. *Neopelecanus rufescens* (Gm.). Pink-backed pelican.
- (M.) *Pectinopygus forficulatum* (Nitzsch).
- (M.) *Tetrophthalmus africanus* Bedford.

44. Family VULTURIDAE.

249. *Gyps coprotheres* (Forst). Cape vulture.
- (M.) *Falcolipeurus lineatus* Bedford.
- (M.) *Colpocephalum caudatum* Giebel.
- (M.) *Laemobothrion titan* (Piaget).

250. *Gyps rüppelli* Bp. Rüppell's vulture.
- (M.) *Falcolipeurus quadripustulatus* (Nitzsch).
- (M.) *Degeeriella fusca* (Nitzsch).
- (M.) *Colpocephalum flavescens* Nitzsch.
- (M.) *Laemobothrion tinnunculi* (Linné).

253. *Pseudogyps africanus fullebornei* Erl. Southern white-backed vulture.
- (M.) *Falcolipeurus africanus* Bedford.
- (M.) *Colpocephalum caudatum* Giebel.
- (M.) *Laemobothrion titan* Piaget.

254. *Neophron perenopterus* (Linné). Egyptian vulture.
- (M.) *Falcolipeurus monilis* (Nitzsch).
- (M.) *Menopon albidum* Giebel.
- (M.) *Menacanthus fulvofasciatus* (Piaget).
- (M.) *Laemobothrion percnopteri* Gervais.

45. Family SAGITTARIIDAE.

256. *Sagittarius serpentarius* (Miller). Secretary bird.
- (I.A.) *Argas persicus* (Oken).
- (M.) *Falcolipeurus secretarius* (Giebel).
- (M.) *Colpocephalum cucullare* Giebel.

46. Family FALCONIDAE.

259. *Circus aeruginosus* (Linné). European marsh harrier.
- (M.) *Degeeriella fusca* (Nitzsch).
- (M.) *Philopterus nisi* (Denny).
- (M.) *Colpocephalum bicinctum* Nitzsch.
- (M.) *Laemobothrion tinnunculi* (Linné).

260. *Pseudocircus macrourus* (Gm.). Pallid harrier.
- (M.) *Degeeriella fusca* (Nitzsch).

261. *Melanocircus maurus* (Temm.). Black harrier.
- (M.) *Degeeriella rufa* (Nitzsch).

262. *Pygargus pygargus* (Linné). Montagu's harrier.
- (A.A.) *Pterolichus nisi* (Can.).

263. *Melierax musicus* (Daud.). Chanting goshawk.
(M.) *Degeeriella fusca* (Nitzsch).

265. *Micronisus gabar* (Daud.). Gabar goshawk.
(M.) *Degeeriella fusca* (Nitzsch).

267. *Neonisus melanoleucus* (A. Smith). Black sparrowhawk.
(M.) *Degeeriella fusca* (Nitzsch).

268. *Aerospiza tachiro* (Daud.). African goshawk.
(M.) *Degeeriella fusca* (Nitzsch).

273. *Buteo vulpinus* (Gloger). Steppe buzzard.
(Syn. *Buteo desertorum* Daud.).
(M.) *Laemobothrion titan* (Piaget).

275. *Pterolestes rufofuscus* (Forst.). Jackal buzzard.
(M.) *Degeeriella fusca* (Nitzsch).
(M.) *Philopterus platyrhynchus* (Nitzsch).
(M.) *Laemobothrion titan* (Piaget).

277. *Pteroactus verreauxi* (Less.). Black eagle.
(M.) *Degeeriella fusca* (Nitzsch).
(M.) *Laemobothrion titan* (Piaget).

282. *Nisaetus spilogaster* (Bp.). African hawk-eagle.
(M.) *Degeeriella fusca* (Nitzsch).
(M.) *Colpocephalum subpachygaster* Piaget.
(M.) *Laemobothrion titan* (Piaget).

284. *Hieraaetus pennatus* (Gm.). Booted eagle.
(M.) *Degeeriella fusca* (Nitzsch).

289. *Circaetus pectoralis* (A. Smith). Black-chested harrier-eagle.
(M.) *Laemobothrion titan* (Piaget).

292. *Terathopius ecaudatus* (Daud.). Bateleur eagle.
(M.) *Falcolipeurus lineatus* Bedford.
(M.) *Laemobothrion titan* (Piaget).

293. *Cuncuma vocifer* (Daud.). Cape sea-eagle.
(M.) *Degeeriella fusca* (Nitzsch).

294a. *Milvus migrans*. Black kite.
(Syn. *M. ater* and *M. korschum*.)
(M.) *Degeeriella fusca* (Nitzsch).
(M.) *Philopterus spathulatus* (Giebel).
(M.) *Colpocephalum tricinctum* (Nitzsch).
(M.) *Laemobothrion titan* (Piaget).

295. *Milvus aegyptius* Gm. Kite.
(M.) *Degeeriella fusca* (Nitzsch).
(M.) *Philopterus milvi* (Mjöberg).
(M.) *Philopterus spathulatus* (Giebel).
(M.) *Colpocephalum abruptofasciatum* Mjöberg.
(M.) *Colpocephalum dissimile* Piaget.
(M.) *Laemobothrion titan* (Piaget).

296. *Elanus caeruleus* (Desf.). Black-shouldered kite.
  (M.) *Degeeriella fusca* (Nitzsch).

298. *Pernis apivorus* (Linné). Honey buzzard.
  (A.A.) *Pterolichus nisi* (Can.).
  (M.) *Degeeriella phlyetopyga* (Nitzsch).
  (M.) *Philopterus aquilinus* (Denny).
  (M.) *Philopterus cornutus* (Piaget).
  (M.) *Colpocephalum flavescens* Nitzsch.

300. *Rhynchodon peregrinus minor* (Bp.). Peregrine Falcon.
  (M.) *Colpocephalum flavescens* Nitzsch.

302. *Falco subbuteo* (Linné). Hobby.
  (A.A.) *Pterolichus minor* Mégn. & Trt.
  (M.) *Degeeriella rufa* (Nitzsch).
  (M.) *Laemobothrion tinnunculi* (Linné).

309. *Cerchneis rupicola* (Daud.). South African kestrel.
  (M.) *Degeeriella fusca* (Nitzsch).
  (M.) *Laemobothrion tinnunculi* (Linné).

311. *Tichornis naumanni* (Fleisch). Lesser kestrel.
  (M.) *Degeeriella fusca* (Nitzsch).

47. Family PANDIONIDAE.

313. *Pandion haliaetus* (Linné). Osprey.
  (A.A.) *Buchholzia fuscus* (Nitzsch).
  (M.) *Kurodaia haliaeeti* (Denny).
  (M.) *Colpocephalum flavescens* Nitzsch.
  (M.) *Laemobothrion titan* (Piaget).

48. Family TYTONTIDAE.

314. *Tyto alba affinis* (Lay.). Cape barn owl.
(Syn. *Strix flaminea.*)
  (M.) *Philopterus rostratus* (Nitzsch).
  (M.) *Colpocephalum subpachygaster* Piaget.
  (S.T.) *Echidnophaga gallinacea* (Westw.).

49. Family BUBONIDAE.

317. *Nyctaetus lacteus* (Temm.). Giant eagle owl.
  (M.) *Eustrigiphilus ceblebrachys* (Nitzsch).
  (M.) *Philopterus cursor* (Nitzsch).

318. *Bubo capensis* A. Smith. Cape eagle owl.
  (M.) *Philopterus cursor* (Nitzsch).
  (M.) *Philopterus rostratus* (Nitzsch).
  (M.) *Colpocephalum subpachygaster* Piaget.

319. *Bubo africanus* (Temm.). Cape spotted eagle owl.
(Syn. *Bubo maculosus.*)
  (I.I.) *Hyalomma aegyptim impressum* Koch.
  (M.) *Philopterus cursor* (Nitzsch).

320. *Phasmaptynx capensis* (A. Smith). Cape marsh owl.
(M.) *Philopterus cursor* (Nitzsch).

323. *Strix woodfordi* (A. Smith). Woodford's bush owl.
(M.) *Philopterus cursor* (Nitzsch).

50. Family PSITTACIDAE.

326. *Poicephalus meyeri damarensis* Neum. Transvaal Meyer's parrot.
(M.) *Psittacomenopon poicephalum* (Bedford).

329. *Poicephalus robustus* (Gm.). Cape parrot.
(M.) *Psittacomenopon poicephalum* (Bedford).

52. Family CORACIIDAE.

333. *Coracias garrulus* Linné. European roller.
(M.) *Degeeriella subcuspidata* (Nitzsch).
(M.) *Menopon virgo* Giebel.

53. Family ALCEDINIDAE.

340. *Ceryle rudis* (Linné). Pied kingfisher.
(M.) *Philopterus duplicatus* (Piaget).

347. *Chelicutona albiventris* (Scop.). Brown-hooded kingfisher.
(M.) *Philopterus capistratus* Neumann.

54. Family BUCEROTIDAE.

349. *Bucorvus schlegeli* Roberts. South African hornbill.
(Syn. *Bucorvus cafer* Schl.).
(M.) *Chapinia africana* (Bedford).

350. *Baryrhynchus cristatus* (Rüpp.). Crested hornbill.
(M.) *Allomenopon bucerotis* (Kellogg).

351. *Bycanistes bucinator* (Temm.). Trumpeter hornbill.
(M.) *Allomenopon bucerotis* (Kellogg).

352. *Rhynchaceros melanoleucus* (Lcht.). Crowned hornbill.
(A.A.) *Pterolichus vexillarius minuta* Mégn. & Trt.

353. *Lophoceros epirhinus* (Sund.). South African grey hornbill.
(M.) *Allomenopon lophocerum* (Bedford).

355. *Tockus erythrorhynchus* (Temm.). Red-billed hornbill.
(A.A.) *Pterolichus vexillarius minuta* Mégn. & Trt.
(M.) *Allomenopon lophocerum* (Bedford).

356. *Xanthorhynchus leucomelas* (Lcht.). Yellow-billed hornbill.
(M.) *Allomenopon lophocerum* (Bedford).

55. Family UPUPIDAE.

358. *Upupa africana* Bechst. African hoopoe.
(M.) *Degeeriella upupae* (Denny).

56. Family MEROPIDAE.

362. *Merops apiaster* Linné. European bee-eater.
- (A.A.) *Pterolichus cuculi* Mégn. & Trt.
- (A.A.) *Allanalges analgoides* (Trt.).
- (M.) *Degeeriella apiaster* (Denny).

367. *Coccolarynx bullockoides* (A. Smith). White-fronted bee-eater.
- (M.) *Degeeriella erythropteri* (Piaget).
- (M.) *Cuculoecus meropis* (Denny).

368. *Melittophagus pusillus meridionalis* Sharpe. Little bee-eater.
- (M.) *Degeeriella erythropteri* (Piaget).
- (M.) *Cuculoecus meropis* (Denny).

57. Family CAPRIMULGIDAE.

370. *Caprimulgus europaeus* Linné. European nightjar.
- (M.) *Degeeriella hypoleuca* (Nitzsch).
- (M.) *Philopterus macropus* (Giebel).

58. Family MACROPTERYGIDAE.

383. *Micropus apus* (Linné). European swift.
- (A.A.) *Eustathia cultrifer* (Robin).
- (A.A.) *Chauliacia securiger* (Robin).
- (A.A.) *Mégninia aestivalis* Berl.
- (A.A.) *Alloptes cypseli* Can. & Berl.
- (A.A.) *Trouessartia appendiculata* (Berl.).
- (M.) *Menopon parvulum* Piaget.
- (M.) *Eureum cimicoides* Nitzsch.
- (M.) *Dennyus truncatus* (Von Olfers).

388. *Colletoptera affinis* (Grey). Indian swift.
- (M.) *Dennyus minor* (Kellogg & Paine).
- (D.H.) *Crataerina acutipennis* Austen.

59. Family COLIIDAE.

391a. *Urocolius indicus lacteifrons* (Sharpe). Damara red-faced coly.
- (M.) *Colilipeurus colius* (Bedford).
- (M.) *Machaerilaemus urocolius* Bedford.

391b. *Urocolius indicus transvaalensis* Rbts. Transvaal red-faced coly.
- (M.) *Colilipeurus colius* (Bedford).
- (M.) *Machaerilaemus urocolius* Bedford.
- (D.H.) *Ornitheza metallica* (Schiner).

61. Family MUSOPHAGIDAE.

398. *Crinifer concolor* (A. Smith). Southern grey lourie.
- (A.A.) *Paralges deformis* Trt. & Neum.

62. Family CUCULIDAE.

400. *Oxylophus cafer* (Lcht.). Stripe-breasted cuckoo.
- (M.) *Cuculiphilus fasciatus* (Scopoli).

405. *Cuculus canorus* Linné. European cuckoo.
- (A.A.) *Pterolichus cuculi* Mégn. & Trt.
- (A.A.) *Xolalges scaurus* Trt.
- (M.) *Degeeriella latirostris* (Burm.)
- (M.) *Cuculoecus latifrons* (Nitzsch).

407. *Notococcyx solitarius* (Steph.). Red-chested cuckoo.
- (M.) *Degeeriella latirostris* (Burm.).
- (M.) *Cuculiphilus fasciatus* (Scopoli).

409. *Lampromorpha cuprea* (Bodd.). Bronze cuckoo.
- (M.) *Cuculiphilus fasciatus* (Scopoli).

411. *Chrysococcyx intermedius sharpei* van Som. Southern emerald cuckoo.
- (A.A.) *Allanalges podagricus* Trt.

412. *Centropus senegalensis* (Linné). Senegal coucal.
- (I.I.) *Haemaphysalis hoodi* Warb. & Nuttall.

413. *Centropus burchelli* Swains. Burchell's coucal.
- (I.I.) *Haemaphysalis hoodi* Warb. & Nuttall.

69. Family HIRUNDINIDAE.

443. *Hirundo rustica* Linné. European swallow.
- (M.) *Degeeriella gracilis* (Nitzsch).
- (M.) *Philopterus excisus* (Nitzsch).
- (M.) *Myrsidea rustica* (Nitzsch).
- (M.) *Hirundoecus malleus* (Nitzsch).

451. *Chelidonaria urbica* (Linné). House martin.
- (A.A.) *Pteronyssus obscurus* Berl.
- (A.A.) *Mégninia aestivalis subintegra* Berl.
- (A.A.) *Trouessartia appendiculata minutipes* (Berl.).
- (A.A.) *Pterodectes rutilus* Robin.
- (M.) *Degeeriella gracilis* (Nitzsch).
- (M.) *Philopterus excisus* (Nitzsch).
- (M.) *Philopterus quinquemaculatus* (Piaget).

453. *Petrochelidon spilodera* (Sund.).
- (I.A.) *Argas pérenguеyi* (Bedf. & Hewitt).
- (S.P.) *Xenopsylla trispinus* Waterston.
- (D.H.) *Ornithomyia inocellata* Ferris.

458. *Riparia riparia* (Linné). European sandmartin.
- (A.A.) *Pteronyssus obscurus* Berl.
- (A.A.) *Pteronyssus nuntiaeveris* Berl.
- (A.A.) *Mégninia aestrivalis subintegra* Berl.
- (A.A.) *Trouessartia appendiculata* (Berl.).
- (M.) *Degeeriella tenuis* (Nitzsch).
- (M.) *Myrsidea rustica* (Nitzsch).

70. Family LANIIDAE.

463. *Enncoctonus collurio* (Linné). Red-backed shrike.
(M.) *Degeeriella cruciata* (Burm.)
(M.) *Philopterus lanii* (Fabr.).
(M.) *Menopon coarctatum* (Scop.).
(M.) *Menopon inaequale* Piaget.

466. *Laniarius ferrugineus* (Gmel.). Ferruginous bush-shrike.
(M.) *Philopterus subflavescens* (Geoff).

74. Family MUSCICAPIDAE.

517. *Alseonax adustus adustus* (Boie). Cape dusky flycatcher
(M.) *Philopterus subflavescens* (Geoff).

518. *Muscicapa striata* Vroeg. Spotted flycatcher.
(A.A.) *Pteronyssus integer* Trt. & Neum.
(M.) *Philopterus subflavescens* (Geoff).

524. *Melaenornis ater* (Sund.). Black flycatcher.
(M.) *Menacanthus spiniferus* (Piaget).

75. Family SYLVIIDAE.

530. *Sylvia curruca* (Linné). Common whitethroat.
(M.) *Philopterus subflavescens* (Geoff).
(M.) *Menacanthus curuccae* (Sch.).

532. *Hippolais coelebs* (Frentzel). Icterine warbler.
(M.) *Philopterus subflavescens* (Geoff).

534. *Acrocephalus arundinaceus* (Linné). Great reed warbler.
(A.A.) *Pteronyssus pallens* Berl.
(A.A.) *Analges bidentatus* Gieb.
(A.A.) *Heteropsorus pteroptopus* Trt. & Neum.

542. *Museipeta schoenobaena* (Linné). European sedge warbler.
(M.) *Philopterus subflavescens* (Geoff).

76. Family PYCNONOTIDAE.

598. *Loidorusa layardi* (Gurn.). Layard's bulbul.
(M.) *Menacanthus spiniferus* (Piaget).

77. Family TURDIDAE.

608. *Turdoides bicolor* (Jard.). White babbler.
(M.) *Menacanthus crateropus* Bedford.

611. *Turdoides jardinei jardinei* A. Sm. Jardine's babbler.
(M.) *Menacanthus crateropus* Bedford.

629. *Oenanthe oenanthe* (Linné). European wheatear.
(M.) *Menopon exile* Nitzsch.

647. *Caffrornis caffra* (Linnaeus). Cape robin.
(I.I.) *Hyalomma aegyptium impressum* Koch. (Immature forms).

82. Family NECTARINIIDAE.

683. *Notiocinnyris afer* (Linné). Greater double-collared sunbird.
(A.A.) *Pterodectes megaeaulus* Trt.

83. Family MOTACILLIDAE.

701. *Psomophilus capensis* (Linné). Cape wagtail.
(M.) *Menacanthus* sp.

706. *Spipola trivialis* (Linné). European tree pipit.
(A.A.) *Pterodectes bilobatus* Robin.

84. Family ALAUDIDAE.

735. *Calendula magnirostris* (Steph.). Thick-billed lark.
(I.I.) *Hyalomma aegyptium impressum* Koch. (Nymphs).

85. Family FRINGILLIDAE.

752. *Passer melanurus melanurus* (St. Mull.). Cape black-headed sparrow.
(M.) *Degeeriella vulgata* (Kell. & Chap.).
(M.) *Philopterus subflavescens* (Geoff).
(S.T.) *Echidnophaga gallinacea* (Westw.)

755. *Philetairus socius* (Lath.). Sociable weaver.
(I.A.) *Argas striatus* Bedford.

86. Family PLOCEIDAE.

776. *Steganura paradisea* (Linné). Paradise widowbird.
(A.A.) *Epidermoptes uncinatus* Mégn.
(M.) *Degeeriella bicurvata* (Piaget).

788. *Diatropura procne* (Bodd.). Long-tailed widowbird.
(A.A.) *Pteralloptes trifolium* (Trt.)

794. *Quelea sanguinirostris lathami* (A. Smith). Pink-billed quelea.
(I.I.) *Ixodes daveyi* Nuttall.
(M.) *Machaerilaemus plocei* Bedford.

799. *Amadina erythrocephala* (Linné). Red-headed finch.
(M.) *Degeeriella vulgata* (Kell. & Chap.).

87. Family STURNIDAE.

Sturnus vulgaris Linné. European starling.
(A.A.) *Pteronyssus truncatus* Trt.
(A.A.) *Tronessartia corvina rosteri* (Berl.).
(M.) *Degeeriella nebulosa* (Burm.).
(M.) *Philopterus sturni* (Schrank).
(M.) *Myrsidea cucullaris* (Nitzsch).

Acridotheres tristis (Indian minor).
(M.) *Menacanthus spiniferus* (Piaget).

845. *Lamprocolius phoenicopterus phoenicopterus* (Swains). Cape glossy starling.

(M.) *Philopterus senegalensis* (Rudow).

845a. *Lamprocolius phoenicopterus bispecularis* (Strick). Northern glossy starling.

(M.) *Philopterus senegalensis* (Piaget).
(M.) *Menacanthus spiniferus* (Piaget).

853. *Amydrus morio* (Linné). Common redwing starling.

(I.I.) *Haemaphysalis hoodi* Warb. & Nutt.

89. Family ORIOLIDAE.

859. *Oriolus oriolus* (Linné). European golden oriole.

(M.) *Degeeriella munda* (Nitzsch).
(M.) *Philopterus ornatus* (Nitzsch).
(M.) *Ricinus dolichocephalus* (Scop.).

860. *Oriolus larvatus larvatus* Lcht. Cape black-headed oriole.

(M.) *Philopterus ornatus* (Nitzsch).
(M.) *Ricinus dolichocephalus* (Scop.).

91. Family CORVIDAE.

863. *Corvus albus* Müll. (=C. scapulatus Daud.). Pied crow.

(A.A.) *Gabucinia delibata* (Robin).
(M.) *Degeeriella bipunctata* (Rudow).
(M.) *Degeeriella quadrangularis* (Rudow).
(M.) *Philopterus semisignatus* (Nitzsch).
(M.) *Menacanthus corvus* Bedford.
(M.) *Myrsidea obovata* (Piaget).
(M.) *Myrsidea ovata* (Piaget).
(M.) *Myrsidea sjoestedti* (Kellogg).
(M.) *Colpocephalum semicinctum* Rudow.

864. *Heterocorax capensis* (Lcht.). Black crow.

(M.) *Degeeriella varia* (Nitzsch).
(M.) *Menacanthus corvus* Bedford.

865. *Corvultur albicollis* (Lath.). White-necked raven.

(A.A.) *Gabucinia delibata* (Robin).
(M.) *Degeeriella leucocephala* (Nitzsch).
(M.) *Degeeriella varia* (Nitzsch).
(M.) *Philopterus leptomelas* (Giebel).
(M.) *Myrsidea nigra* (Kellogg & Paine).
(M.) *Myrsidea sjoestedti* (Kellogg).

V.—HOST-LIST OF THE ECTOPARASITES FOUND ON SOUTH AFRICAN REPTILES.

Sub-class CHELONIA.

Family TESTUDINIDAE.

Testudo angulata Schweigg. Angulated tortoise.
(I.I.) *Amblyomma latum* (Koch).

Testudo oculifera Kuhl.
(I.A.) *Argas moubata* Murray.

Testudo verreauxii Smith.
(I.A.) *Argas moubata* Murray.

Testudo pardalis Bell.
(I.I.) *Amblyomma marmoreum* Koch.

Sub-class SQUAMATA.

Order LACERTILIA.

Family VARANIDAE.

Varanus albigularis (Daud.).
(I.I.) *Aponomma exornatum* Koch.

Varanus niloticus (Linné). Water leguaan.
(I.I.) *Aponomma exornatum* Koch.

Order OPHIDIA.

Family BOIDAE.

Python sebae (Gmel.). South African python.
(I.I.) *Amblyomma nuttalli* Dönitz.
(I.I.) *Aponomma exornatum* Koch.
(I.I.) *Aponomma globulus* Lucas.
(I.I.) *Aponomma transversale* Lucas.

DIVISION A.—AGLYPHA.

Family COLUBRIDAE.

Pseudaspis cana (Linné). Mole snake.
(I.I.) *Amblyomma latum* (Koch).

DIVISION B.—OPISTHOGLYPHA.

Sub-family ELAPINAE.

Naia flava (Merrem). Cape cobra.
(I.I.) *Aponomma laeve capensis* Neu.

Sepedon haemachates (Lacep). Ringhals.
(I.I.) *Aponomma laeve capensis* Neu.

Dendraspis angusticeps (Smith). Mamba.
(I.I.) *Aponomma laeve capensis* Neu.

" Snake."
(I.I.) *Amblyomma marmoreum* Koch.

TABLE OF DISEASES TRANSMITTED BY SOUTH AFRICAN ECTOPARASITES.

Disease.	Organism Causing Disease.	Host.	Transmitted by.
Bubonic plague.....	*Pasteurella pestis*...	Rodents Man	(S.P.) *Xenopsylla brasiliensis* (Baker). (S.P.) *Xenopsylla cheopis* (Rothsch.). (S.P.) *Xenopsylla eridos* (Rothsch.). (S.P.) *Xenopsylla hirsuta* Ingram. (S.P.) *Ctenocephalides canis* (Curtis). (S.P.) *Ceratophyllus fasciatus* (Bosc.). (S.P.) *Dinopsyllus lypusus* (Jord. and Roths.). (S.P.) *Leptopsylla segnis* (Schönh.).
Tick bite fever......	*Rickettsia sp*.......	Man	(I.I.) Larvae of one or more species of *Ixodidae*.
Typhus fever........	*Rickettsia prowazeki*	Man	(S.) *Pediculus humanus* Linné.
Trench fever........	*Rickettsia quintana**	Man	(S.) *Pediculus humanus* Linné.
Relapsing fever.....	*Treponema obermeieri*†	Man	(S.) *Pediculus humanus* Linné.
Human tick fever or African relap. fever	*Treponema duttoni*..	Man	(I.A.) *Argas moubata* Murray.
Fowl tick fever.....	*Treponema gallinarum*	Fowls	(I.A.) *Argas persicus* (Oken.). (I.A.) *Argas moubata* Murray.
Spirillosis...........	*Treponema theileri*..	Horse Cattle Sheep	(I.I.) *Boophilus decoloratus* (Koch). (I.I.) *Rhipicephalus evertsi* Neu.
Bat spirochaeta......	*Treponema vespertilionis**	Bats	(I.A.) *Argas vespertilionis* (Latr.).
Heartwater.........	*Rickettsia ruminantium*	Cattle Sheep Goats	(I.I.) *Amblyomma hebraeum* Koch. (I.I.) *Amblyomma variegatum* (Fabr.).
Biliary fever or equine piroplasmosis	*Nuttallia equi*......	Horse Mule Donkey	(I.I.) *Rhipicephalus evertsi* Neu.
Biliary fever or canine piroplasmosis	*Piroplasma canis*...	Dog	(I.I.) *Haemaphysalis leachii* (Aud.). (I.I.) *Rhipicephalus sanguineus* (Latr.).
Redwater or bovine piroplasmosis	*Piroplasma bigeminum*	Cattle	(I.I.) *Boophilus decoloratus* (Koch). (I.I.) *Boophilus microplus* (Canestr.). (I.I.) *Rhipicephalus appendiculatus* Neu. (I.I.) *Rhipicephalus evertsi* Neu.
East coast fever.....	*Theileria parva*.....	Cattle	(I.I.) *Rhipicephalus appendiculatus* Neu. (I.I.) *Rhipicephalus capensis* Koch. (I.I.) *Rhipicephalus evertsi* Neu. (I.I.) *Rhipicephalus simus* Koch.

* Not known to occur in South Africa.
† Doubtful whether African relapsing fever is caused by this species.

Disease.	Organism Causing Disease.	Host.	Transmitted by.
Gall-sickness (form of)	*Theileria mutans*....	Cattle	(I.I.) *Rhipicephalus appendiculatus* Neu. (I.I.) *Rhipicephalus evertsi* Neu.
Gall-sickness........	*Anaplasma marginale*	Cattle	(I.I.) *Boophilus decoloratus* Koch. (I.I.) *Rhipicephalus simus* Koch.
Paralysis...........	Toxin.............	Sheep Goats Cattle Vaal rhebok	(I.I.) *Ixodes pilosus* Koch. (I.I.) *Ixodes rubicundus* Neu.
	Haemoproteus columbae	Pigeons	(D.H.) *Pseudolynchia maura* (Bigot.).
Trypanosomiasis of sheep	*Trypanosoma melophagium*	Sheep	(D.H.) *Melophagus ovinus* Linné.
Trypanosomiasis of rats	*Trypanosoma lewisi*	Rats	(S.) *Polyplax spinulosa* (Burm.). (S.P.) *Pulex irritans* Linné. (S.P.) *Xenopsylla brasiliensis* (Baker). (S.P.) *Xenopsylla cheopis* (*Roths.*). (S.P.) *Ctenocephalides canis* (*Curtis*). (S.P.) *Ceratophyllus fasciatus* (Bosc.).
Dog tapeworm......	*Dipylidium caninum*	Dog Cat Man	(M.) *Trichodectes canis* (Degeer).* (S.P.) *Pulex irritans* Linné. (S.P.) *Ctenocephalides canis* (Curtis). (S.P.) *Ctenocephalides felis* (Bouché).
Rat tapeworm*.....	*Hymenolepis diminuta*	Rats Mice Man	(S.P.) *Pulex irritans* Linné. (S.P.) *Xenopsylla cheopis* (Roths.). (S.P.) *Ctenocephalides canis* (Curtis). (S.P.) *Ceratophyllus fasciatus* (Bosc.). (S.P.) *Leptopsylla segnis* (Schönh).
Mouse tapeworm*...	*Hymenolepis microstoma*	Mouse	(S.P.) *Ceratophyllus fasciatus* (Bosc.). (I.I.) *Rhipicephalus sanguineus* (Latr.).
Filaria of dog*......	*Dirofilaria immitis*..	Dog	(S.P.) *Ctenocephalides canis* (Curtis). (S.P.) *Ctenocephalides felis* (Bouché).
Filaria of dog*......	*Dipetalonema reconditum*	Dog	(S.) *Linognathus setosus* (Olfers). (S.P.) *Pulex irritans* Linné. (S.P.) *Ctenocephalides canis* (Curtis). (S.P.) *Ctenocephalides felis* (Bouché).
Filaria of man*.....	*Dipetalonema perstans*	Man	(I.A.) *Argas moubata* Murray. (S.P.) *Pulex irritans* Linné.
Filaria of dog*......	*Dipetalonema grassii*	Dog	(I.I.) *Rhipicephalus sanguineus* (Latr.).

* Not known to occur in South Africa.

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ERRATA.

Rhipicephalus punctatus Bedford (1929) is preoccupied by *R. neavei var. punctatus* Warburton (1912). I therefore propose the name *distinctus* for this species (See page 298).

Acidoproctus rostratus (Rudow) proves to be an immature specimen of *A. bifasciatus* Piaget, not *A. stenopygus* (Nitzsch). I had overlooked Taschenberg's work in which he figures Rudow's type (1882, p. 197, Pl. 7, f. 3). As *A. bifasciatus* was described nine years later it therefore becomes a synonym of *A. rostratus*, and Nitzsch's name *stenopygus* must stand for the second species (See page 333).

The genus *Bathyergicola* Bedford (page 400) should probably be retained until the type of *Proenderleinellus* has been either figured or adequately described.

UNION OF SOUTH AFRICA.

DEPARTMENT OF AGRICULTURE.

AUTHOR AND SUBJECT INDEX

to the

GOVERNMENT VETERINARY REPORTS

of the

TRANSVAAL AND UNION OF SOUTH AFRICA

1903-1932

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FOREWORD.

In the *Journal of the South African Veterinary Medical Association*, Volume 6, No. 2, June, 1935, C. Jackson published a short index to the Government Veterinary Reports of the Transvaal (1903-1910) and the Union of South Africa (1911-1932). The present index is merely an enlarged edition of Jackson's publication.

The need for a fairly detailed index to the publications which emanated from the Government Veterinary Laboratories at Daspoort and Onderstepoort has long been felt. At present the task of finding a reference in these volumes is no easy one: and workers will undoubtedly welcome a handy index volume which will enable them to find with ease information contained in the 26 volumes which it covers.

P. J. DU TOIT,
Director of Veterinary Services.

Onderstepoort, June, 1937

AUTHOR AND SUBJECT INDEX TO THE GOVERNMENT VETERINARY REPORTS

of the

TRANSVAAL AND UNION OF SOUTH AFRICA 1903-1932

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The Reports indexed herein were published between the years 1903 and 1932 and form a continuous series the name of which was modified firstly because of the incorporation of the Transvaal in the Union of South Africa and secondly to conform with subsequent alterations to the title of the Official (formerly Government Veterinary Bacteriologist of the Transvaal) who directed the researches which formed their basis. In 1933 the quarterly *Onderstepoort Journal of Veterinary Science and Animal Industry* replaced the annual Reports, which comprised the following:—

7 Reports of the Government Veterinary Bacteriologist of the Transvaal for the years 1903-1910.

1 Commemoration Report, The Veterinary Bacteriological Laboratories, 1909.

8 Reports (Nos. 1-8) of the Director of Veterinary Research for the years 1911-1918, in 5 volumes.

6 Reports (Nos. 9-14) of the Director of Veterinary Education and Research for the years 1923-1928, in 5 volumes.

1 Report (No. 15) of the Director of Veterinary Services for the year 1929, in 2 volumes, and

3 Reports (Nos. 16-18) of the Director of Veterinary Services and Animal Industry for the years 1930-1932, in 5 volumes.

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Anoplura from South African hosts. (Part II.)
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Report on the transmission of Nagana in the Ntabanana and Mhlatuze Settlements, Zululand.
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,, *pygidiale.*
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,, *harrisoni.*
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,, *querquedulae.*
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,, *rostratula.*
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,, *equi.*
,, *pilosus.*
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,, *cursor.*
,, *cerylinus.*
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,, *excisus.*
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,, *umbrina.*
,, *hoplopteri.*
,, *scolopacis.*
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,, *crassicorne.*
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